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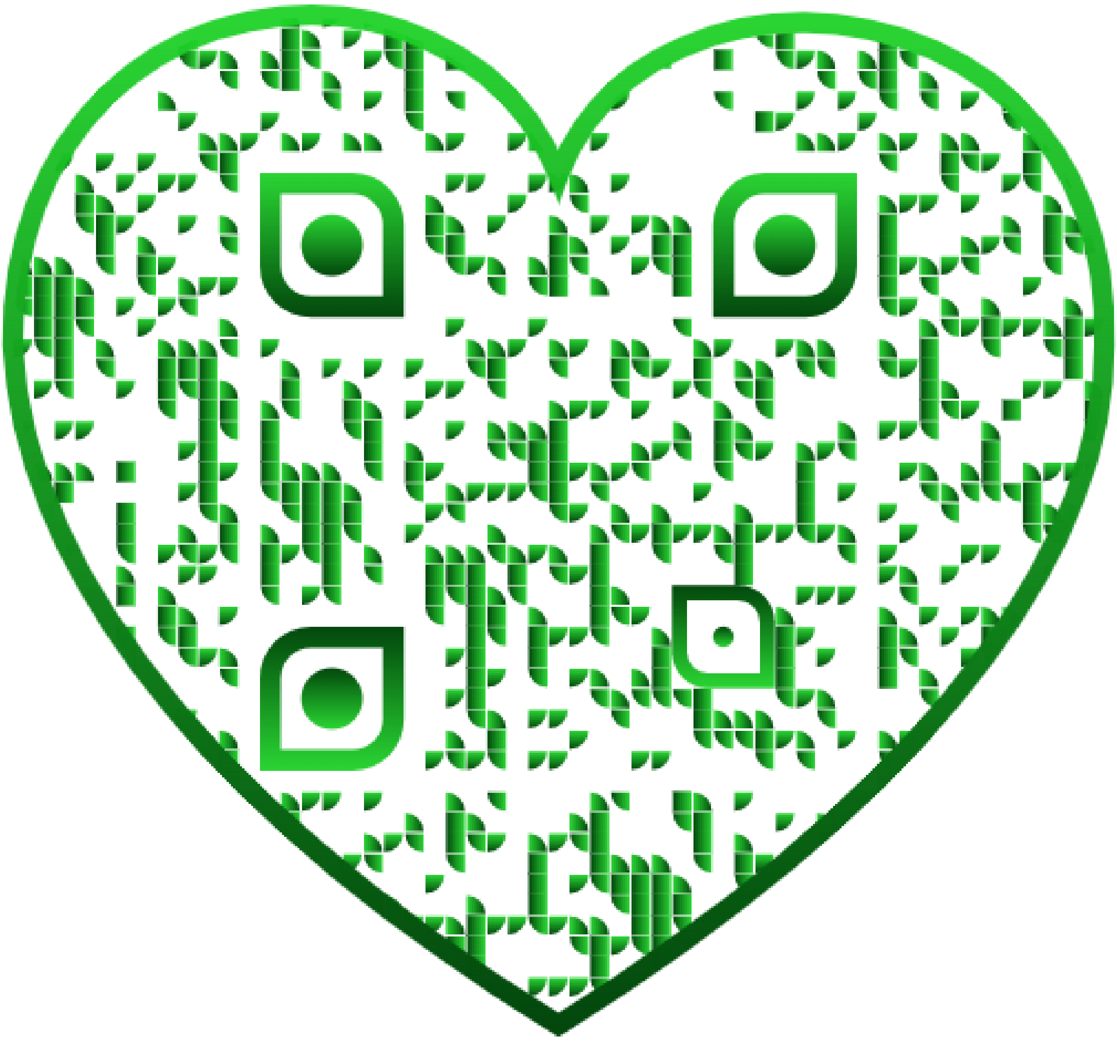

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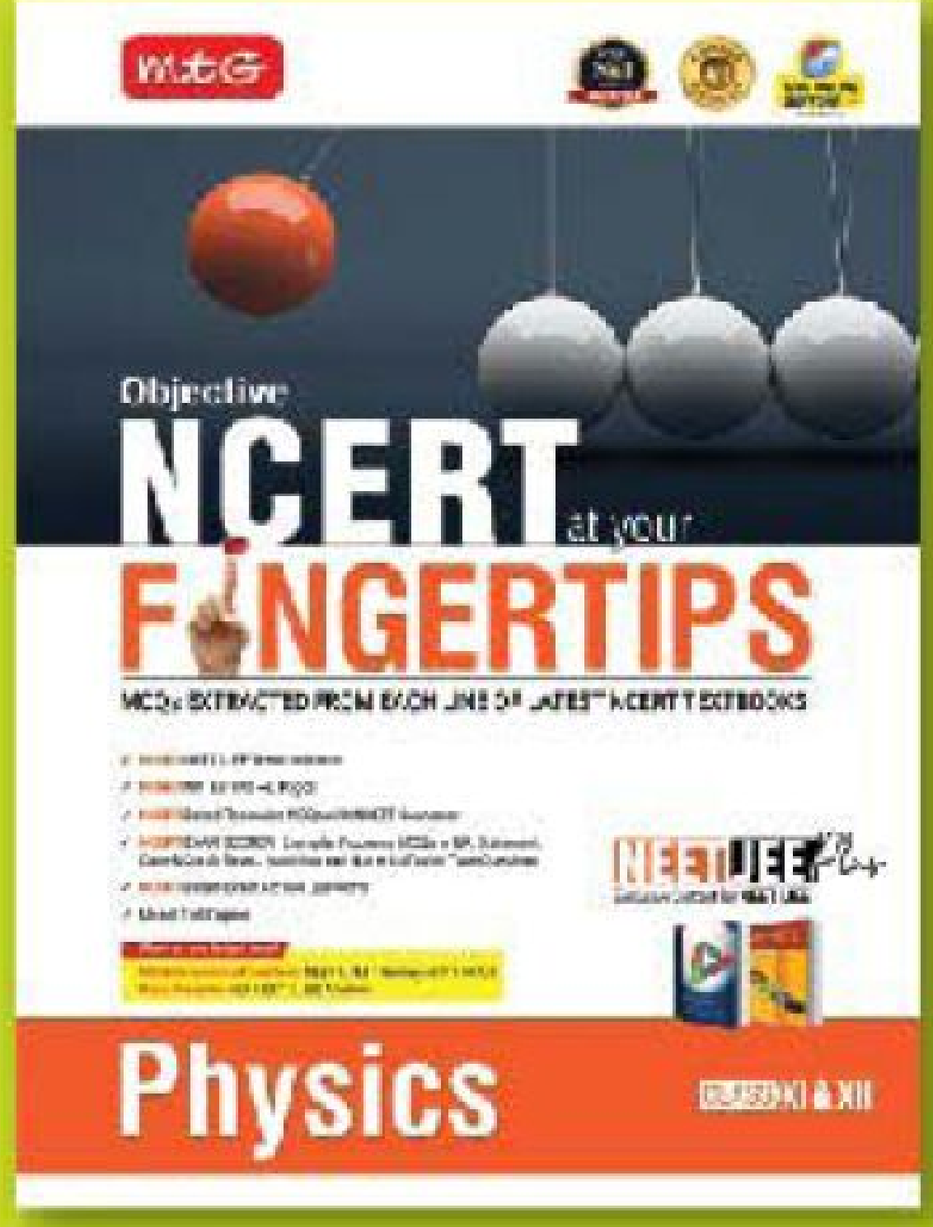
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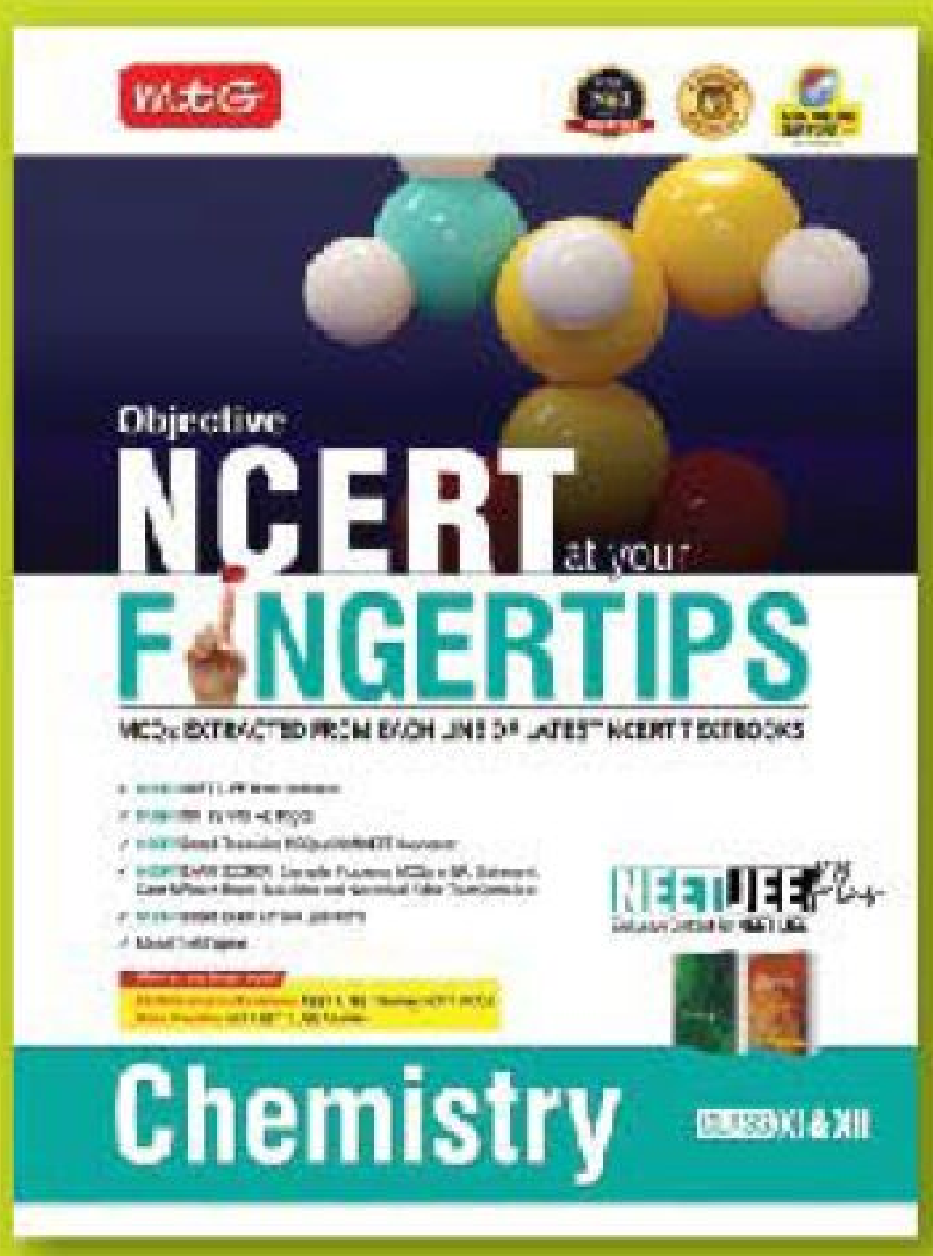
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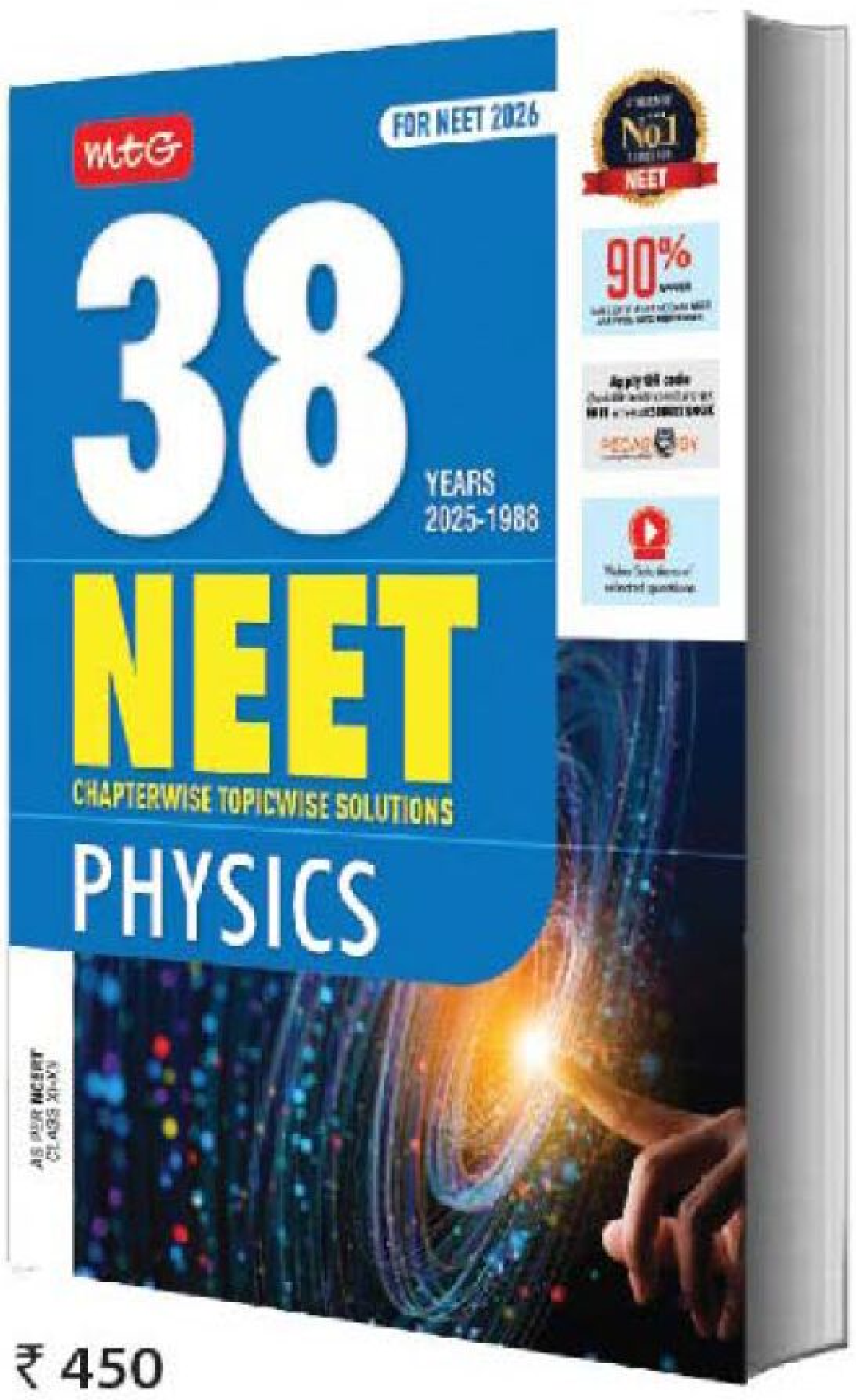
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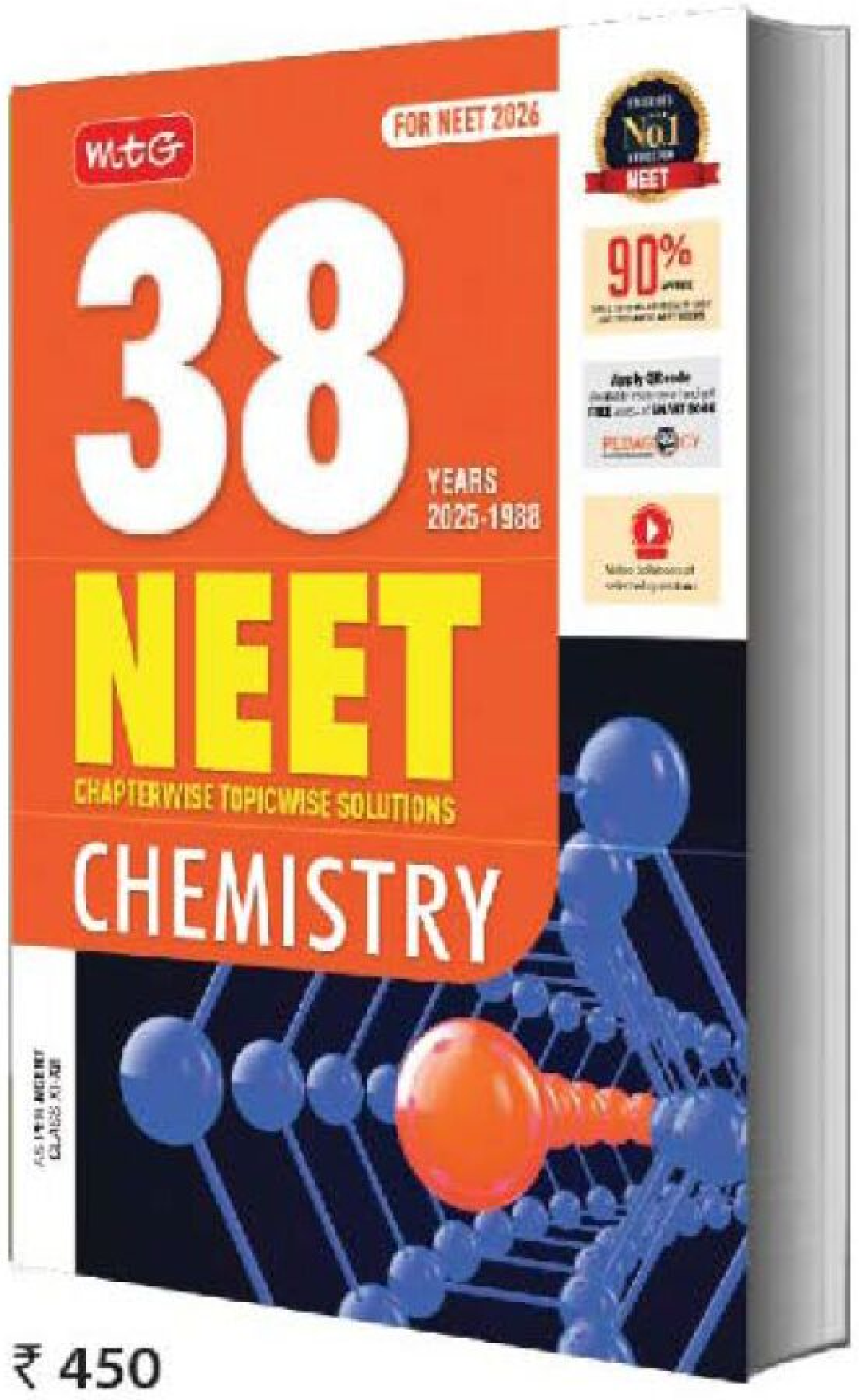
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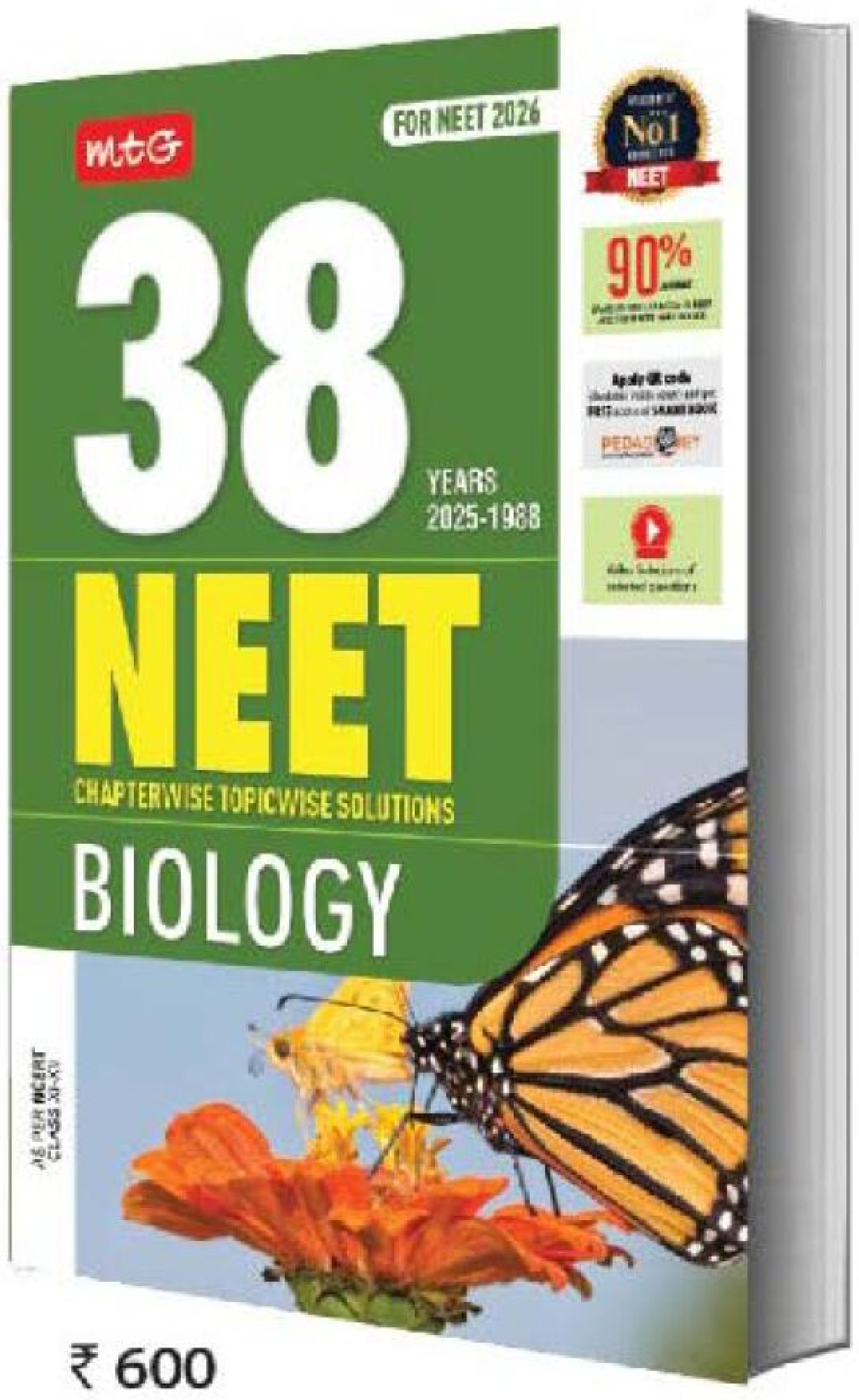
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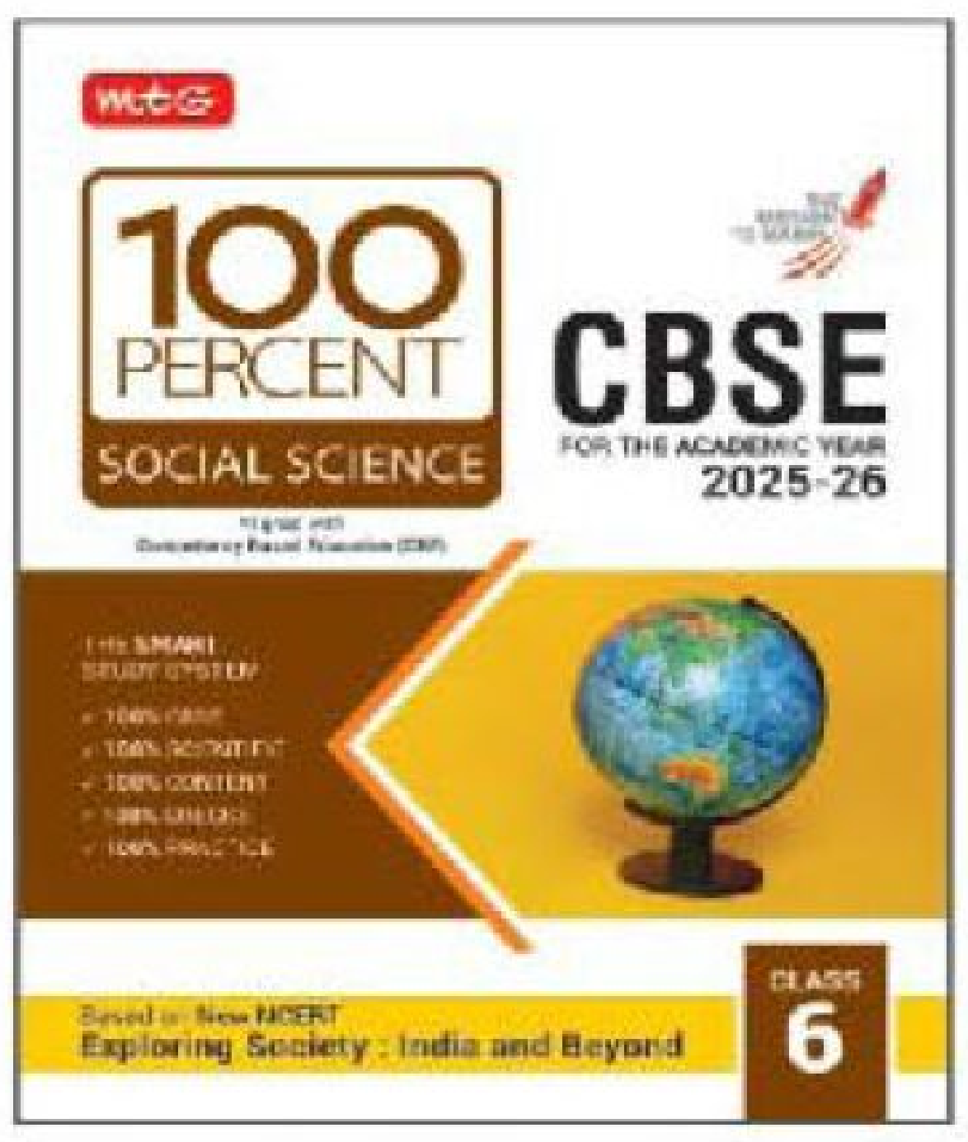
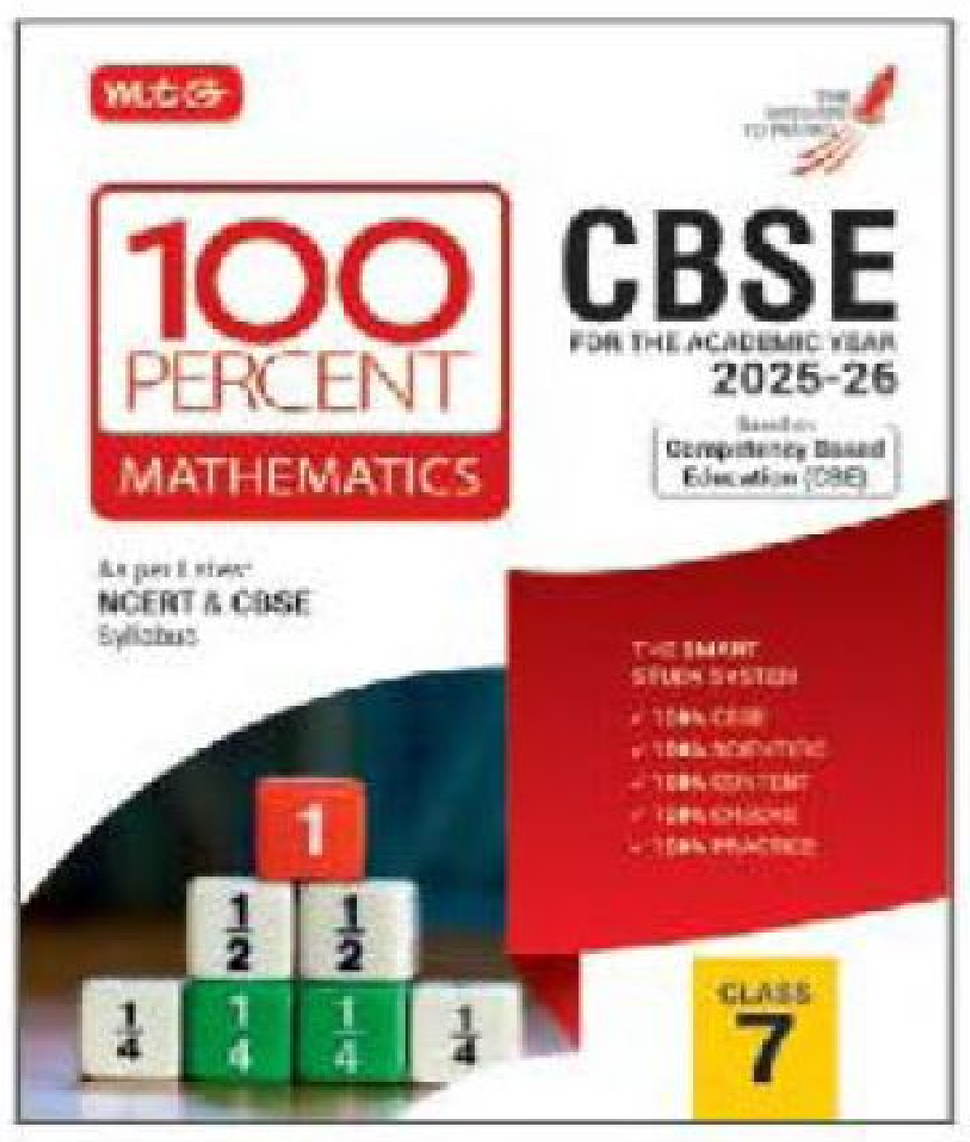
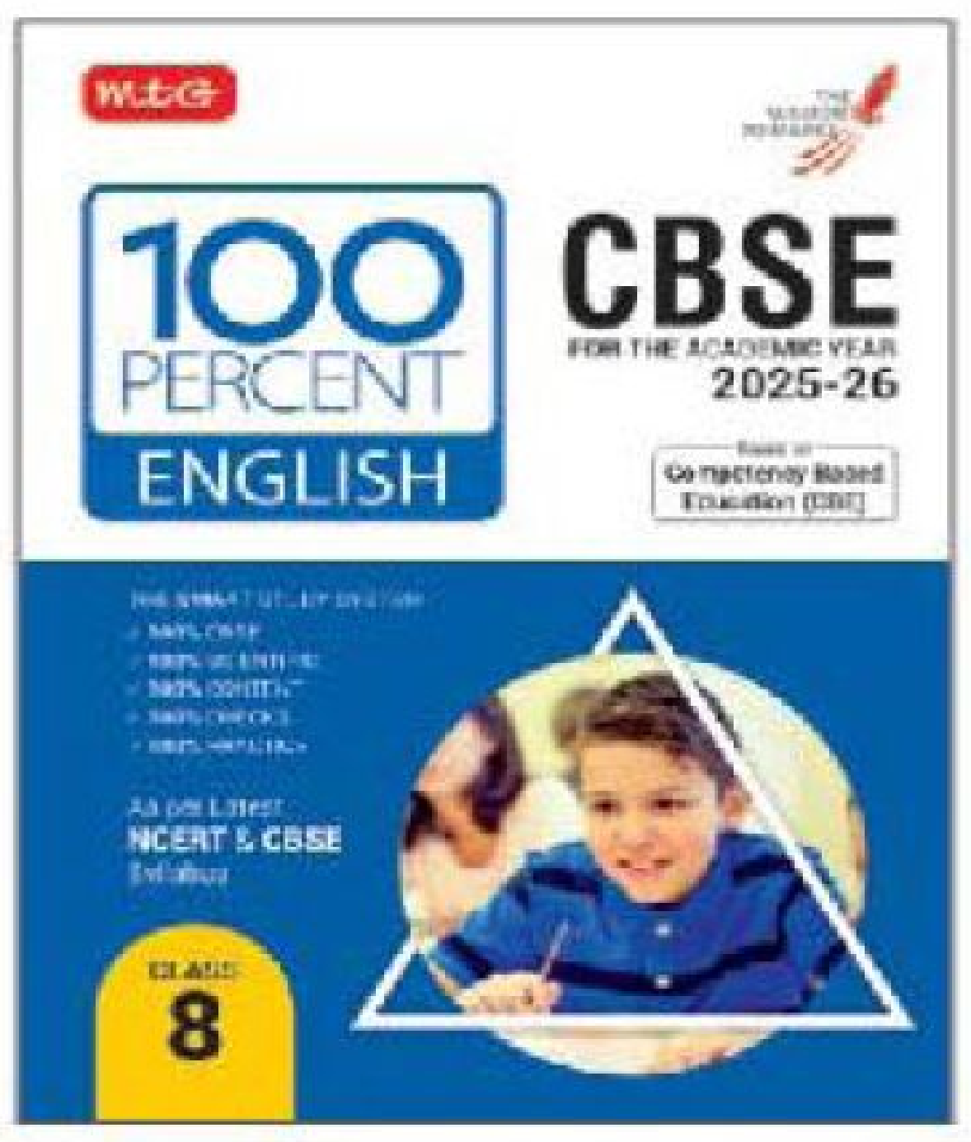
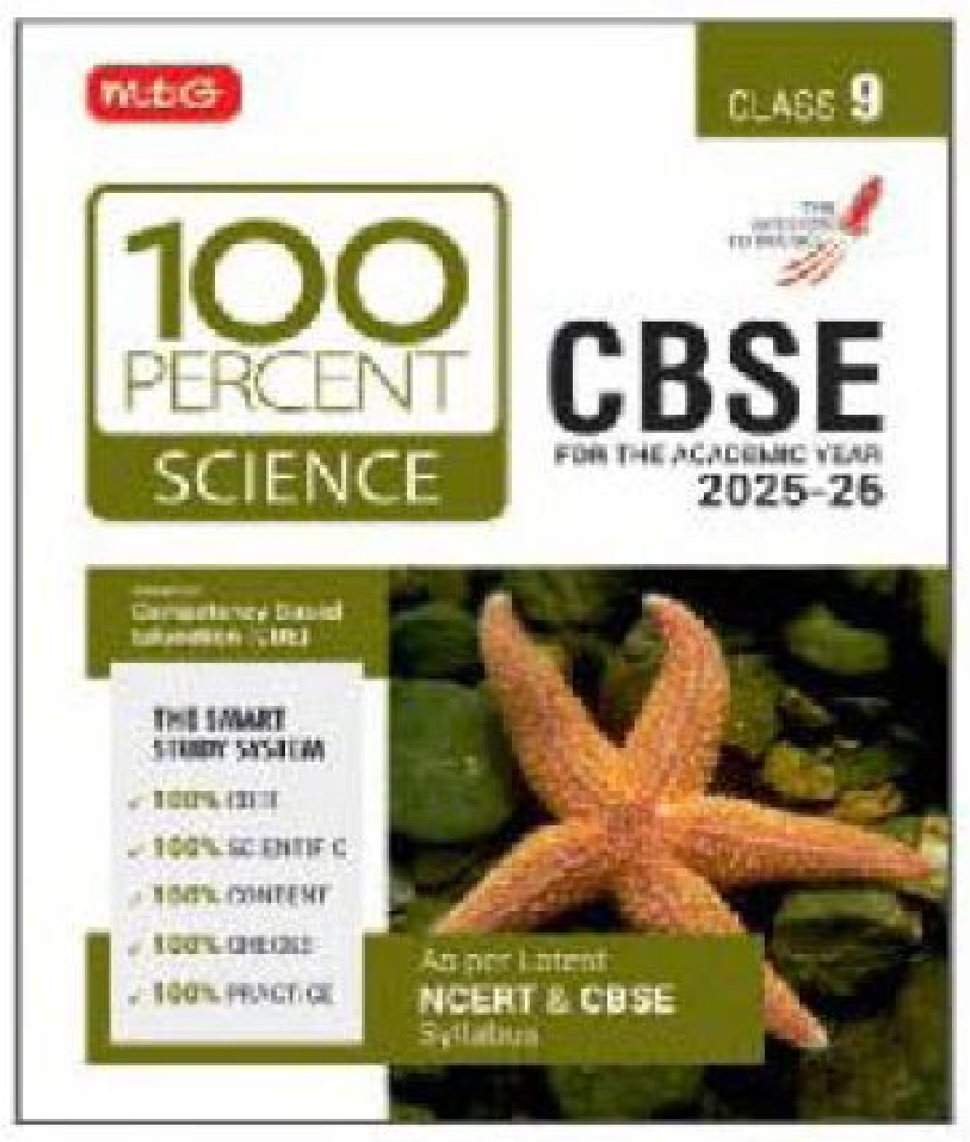
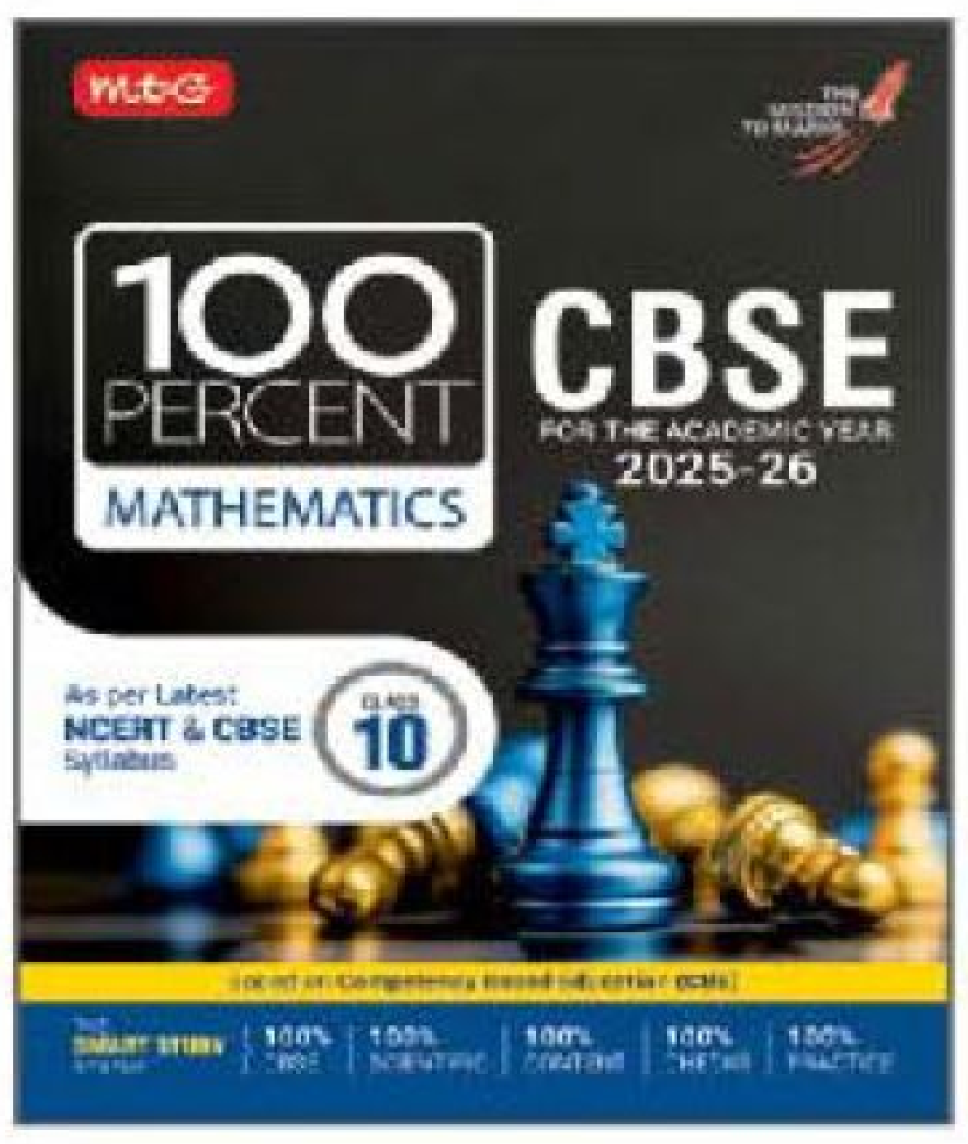
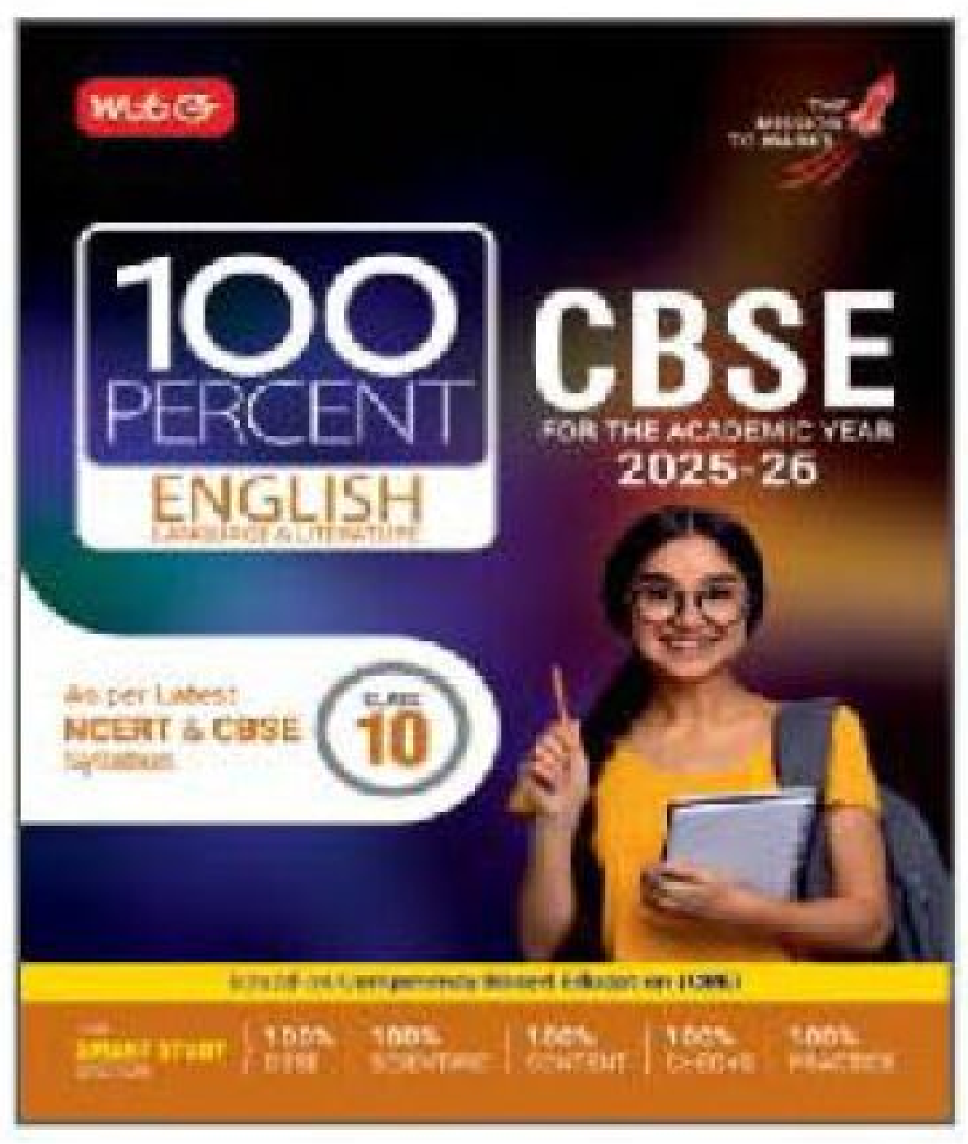
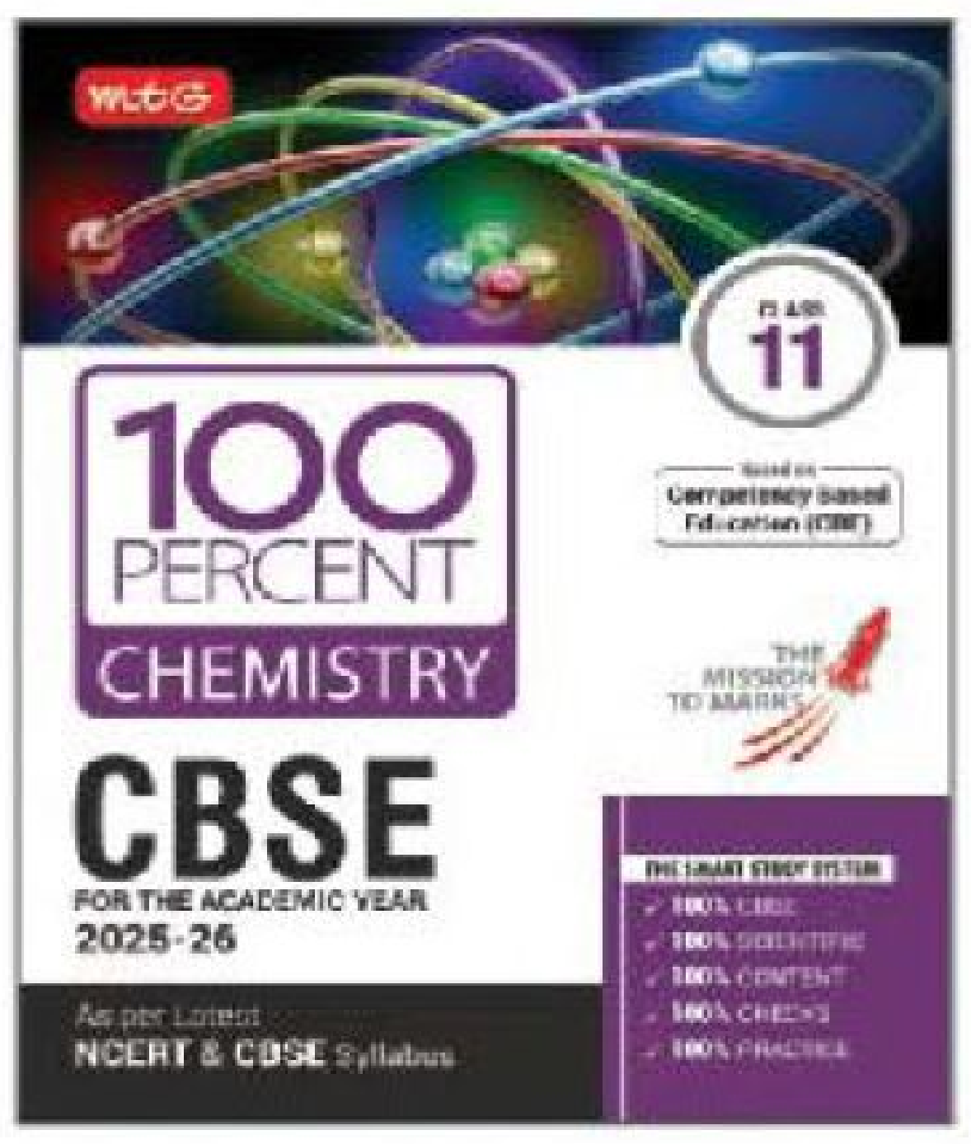
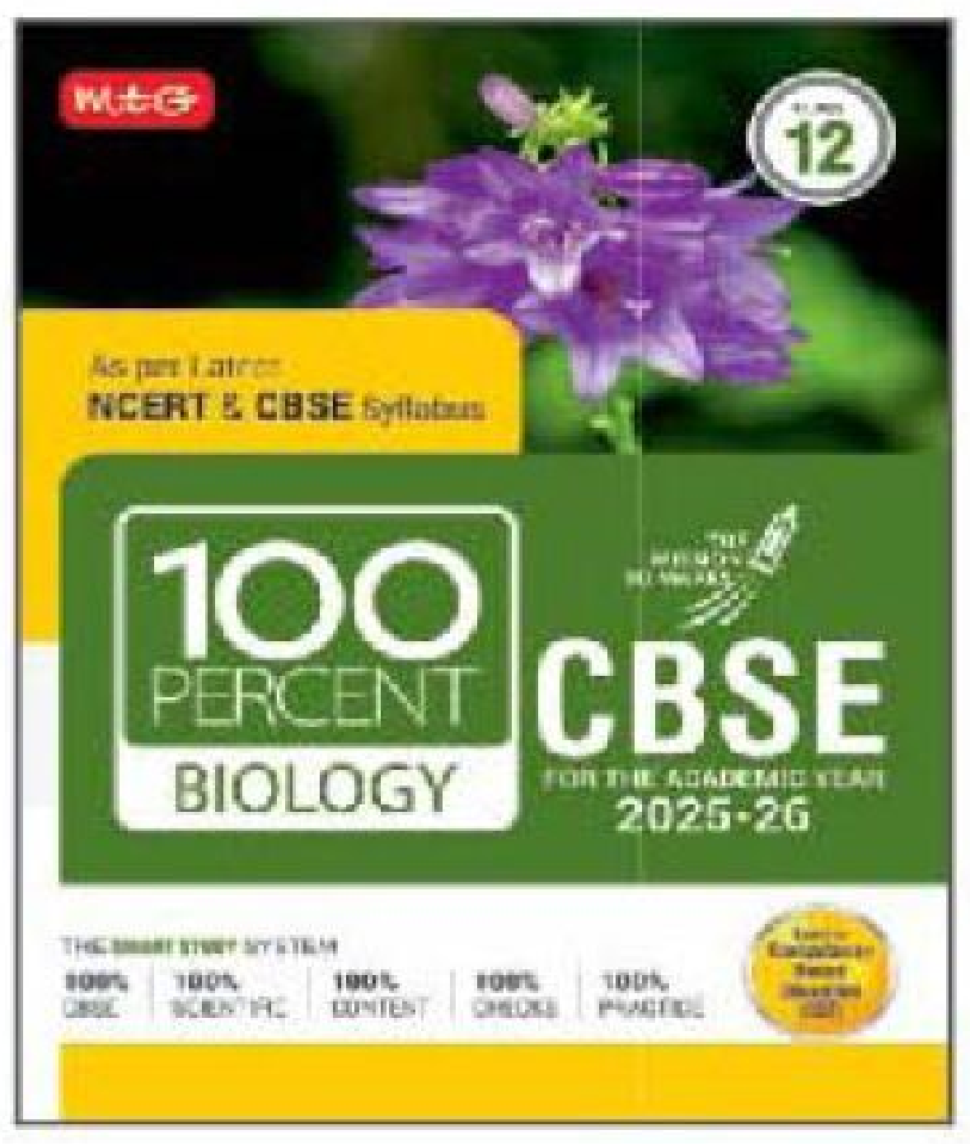

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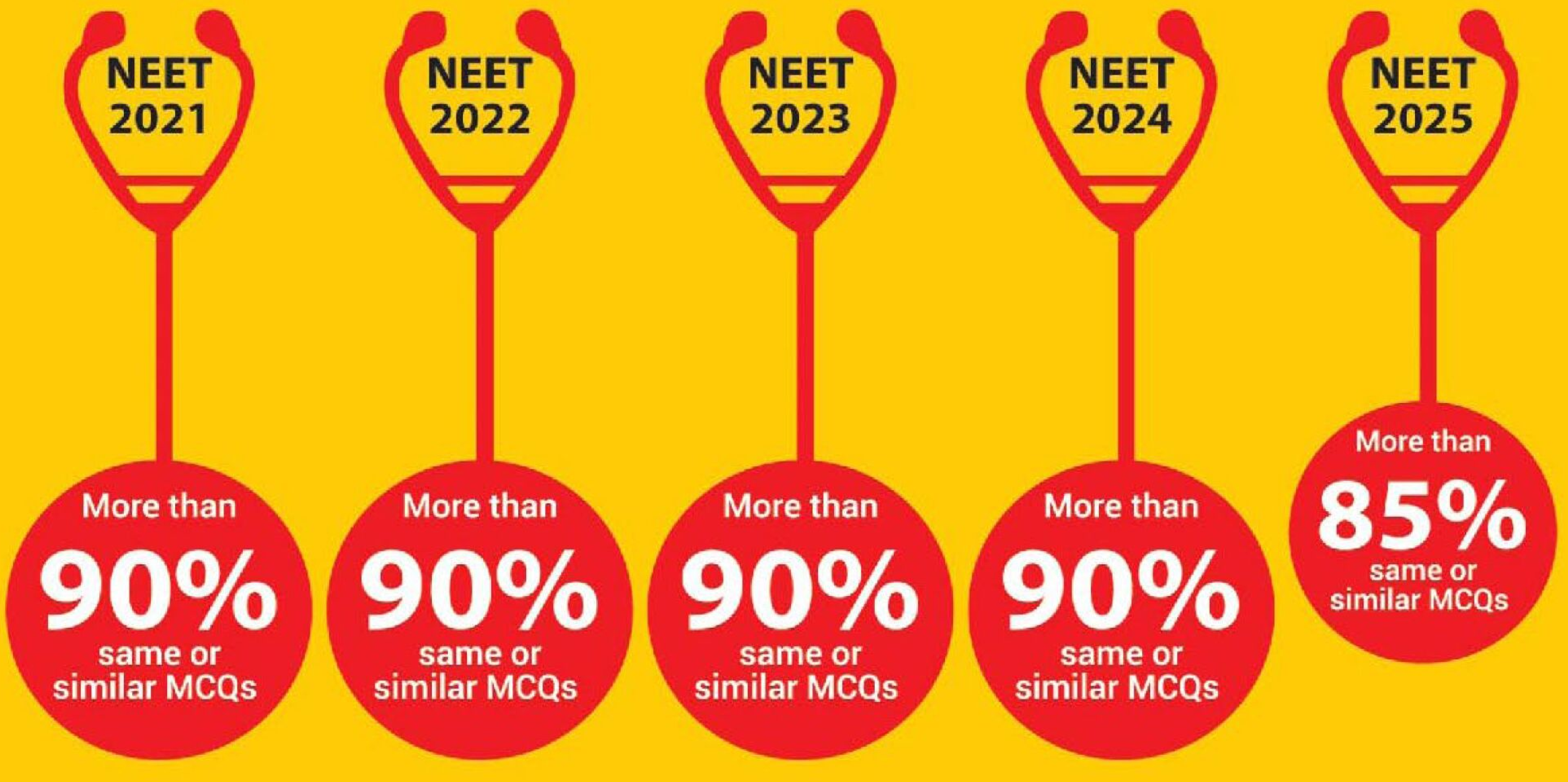
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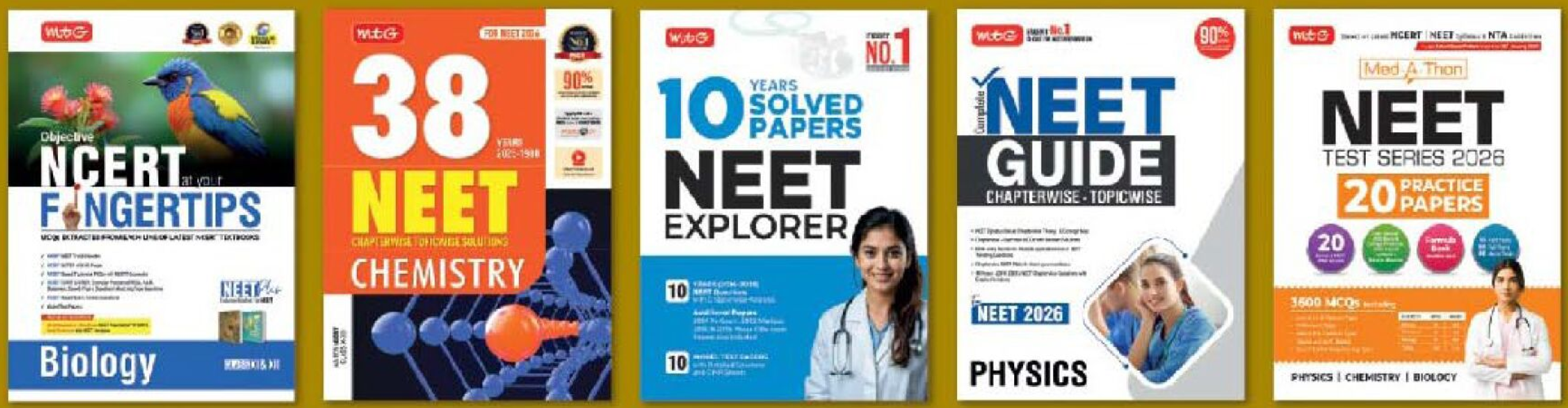
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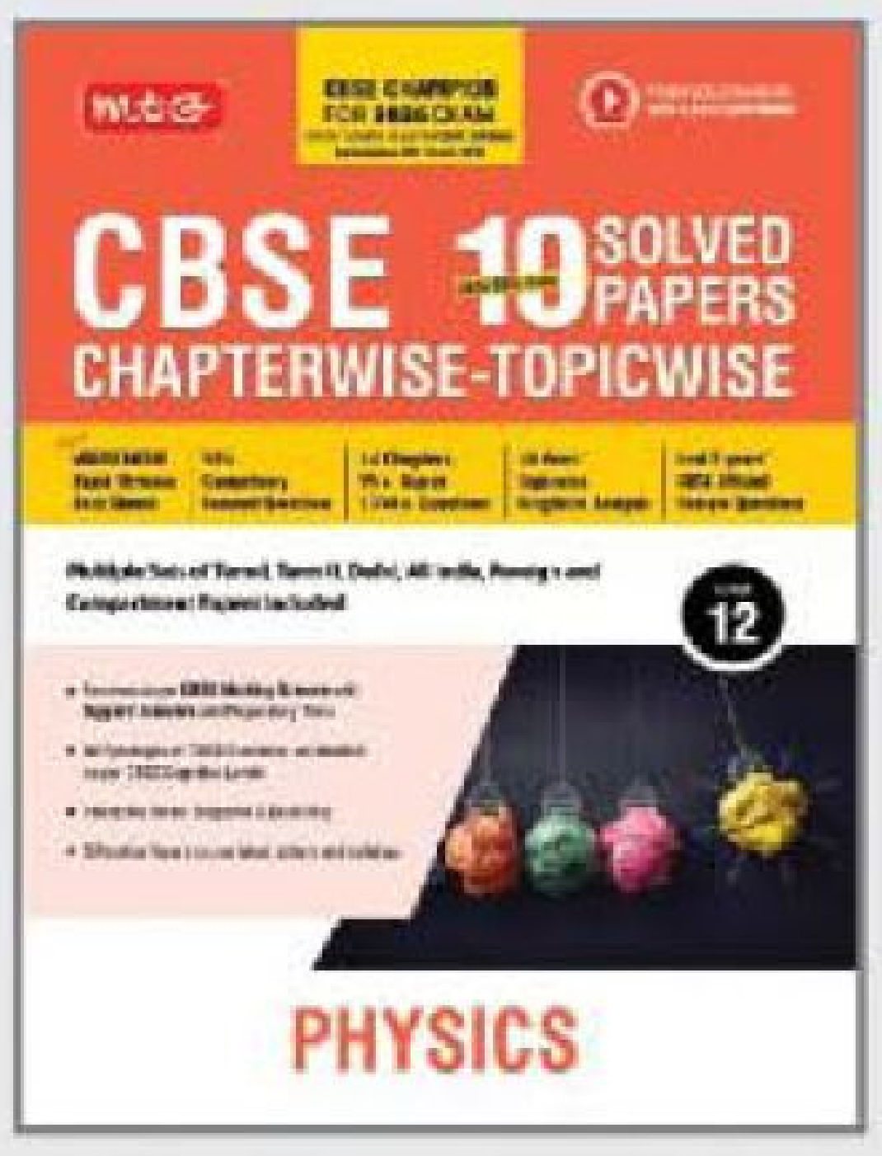
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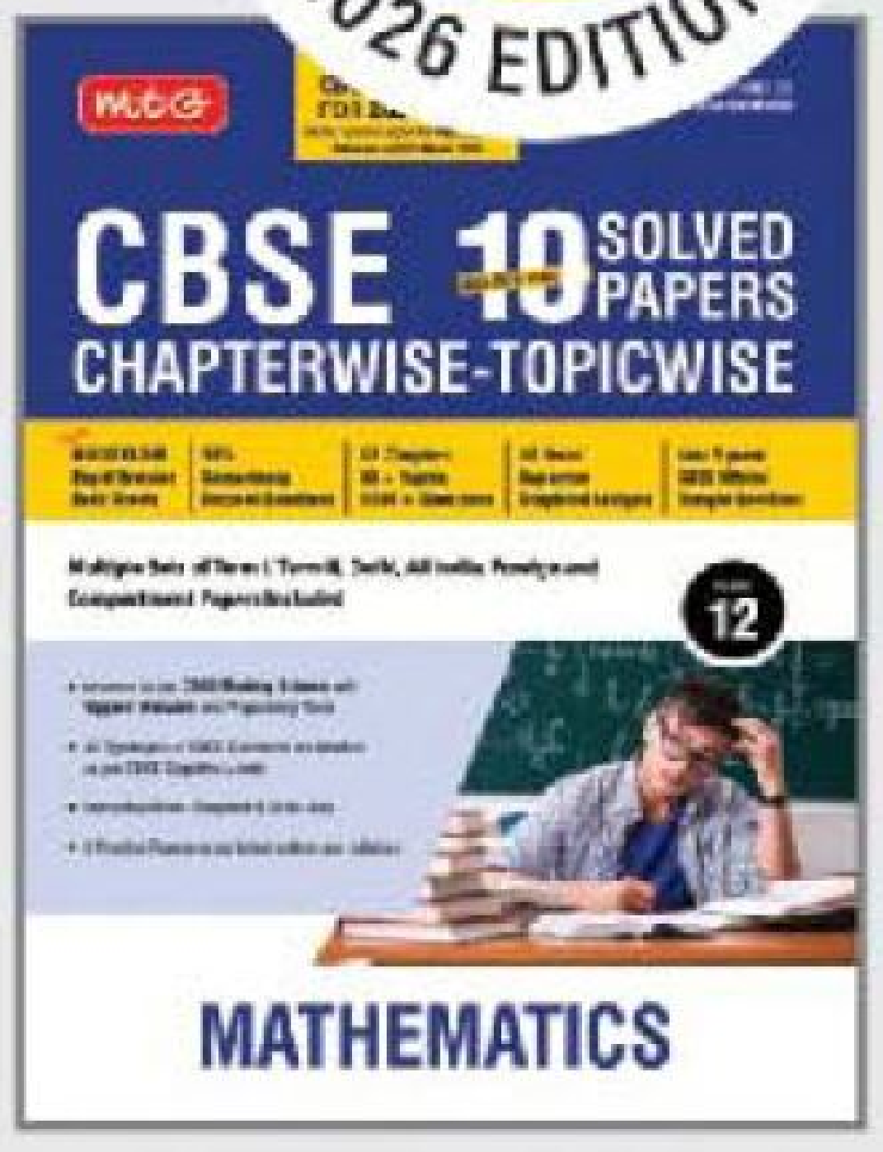
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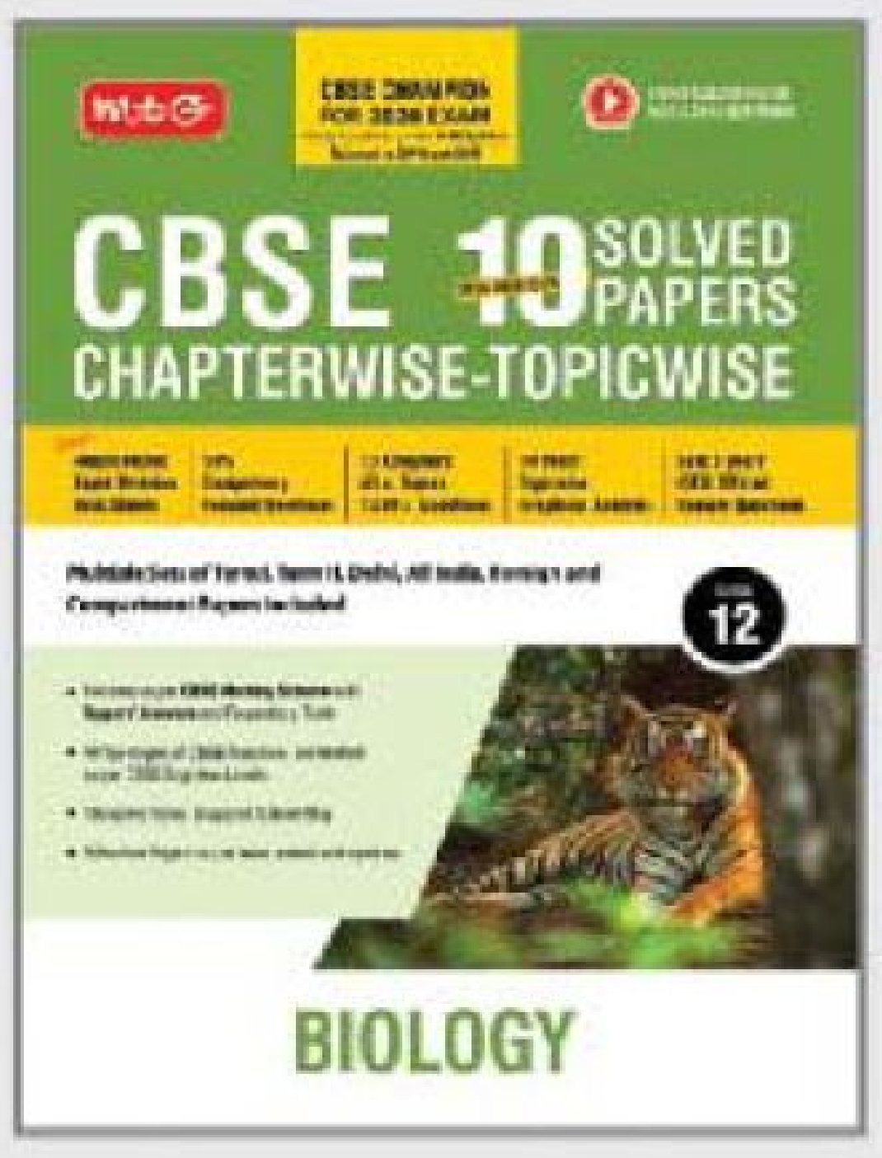
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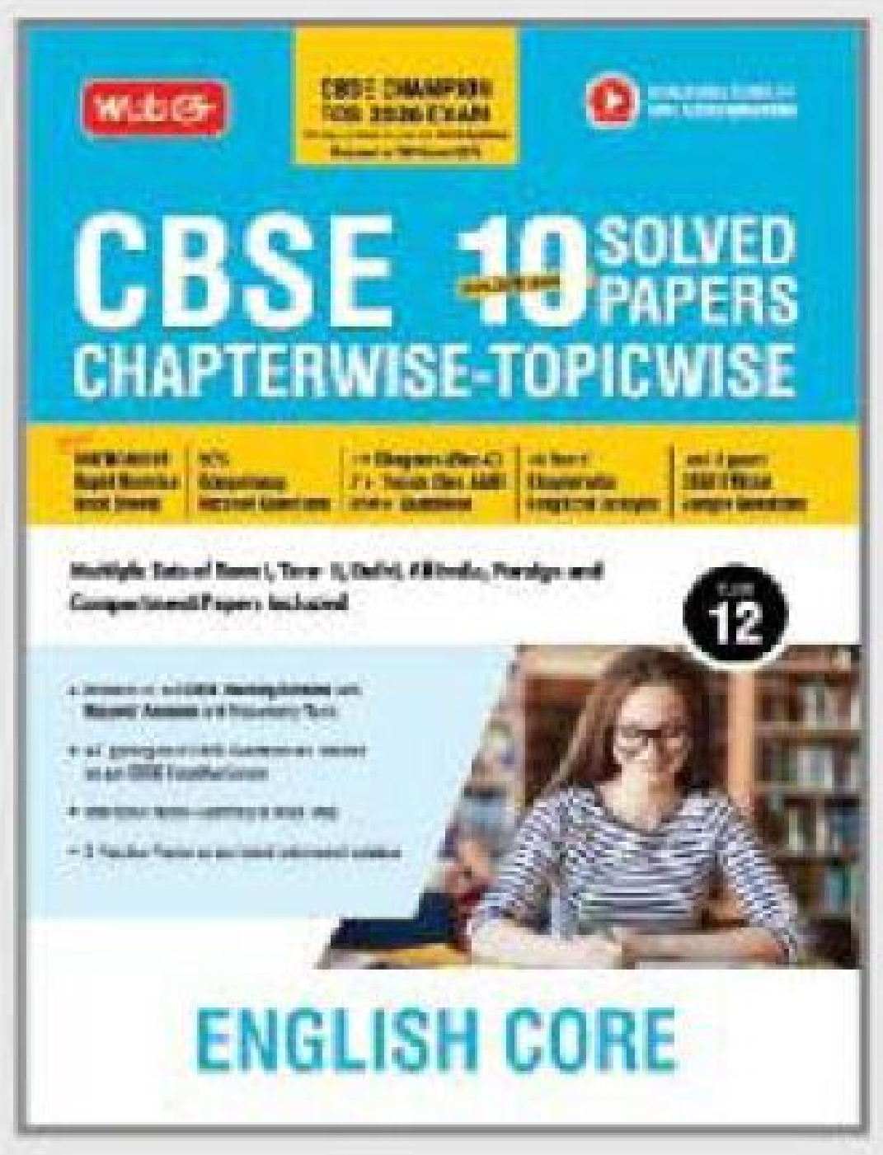
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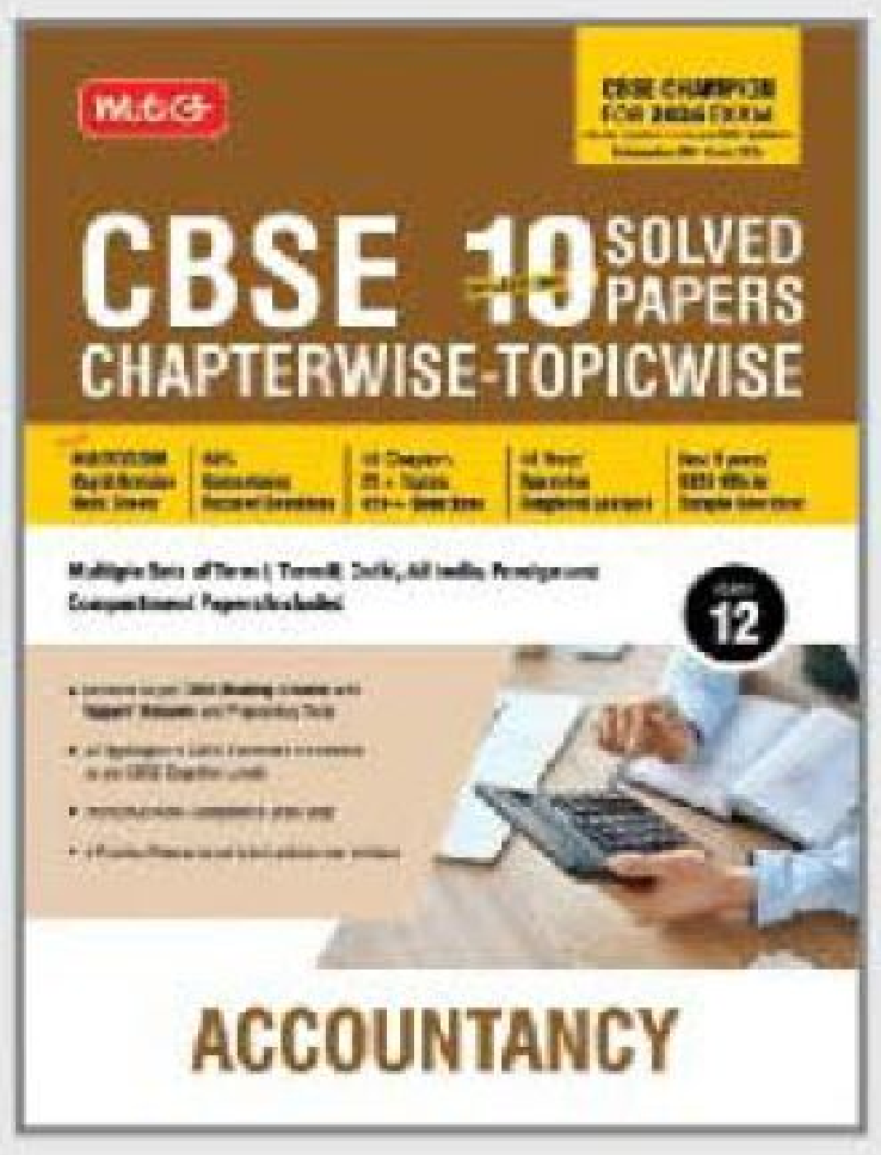
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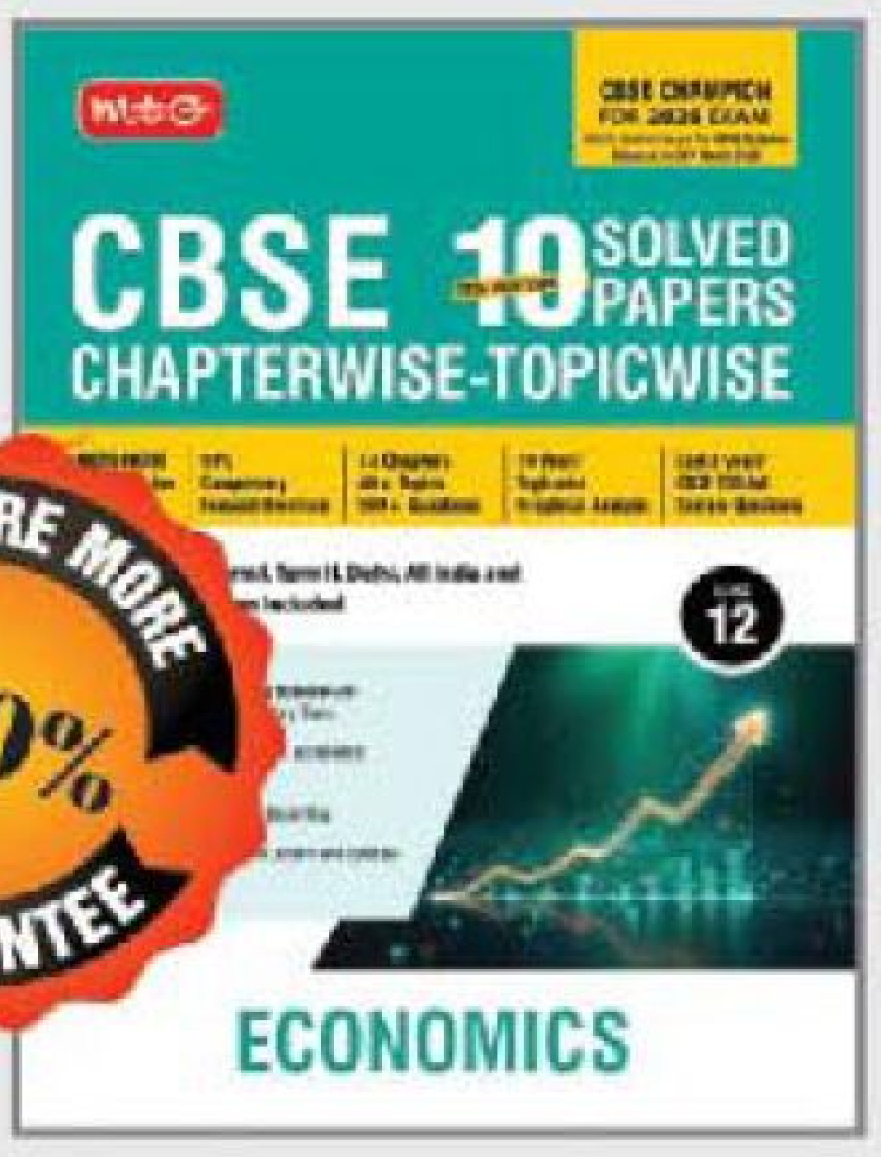
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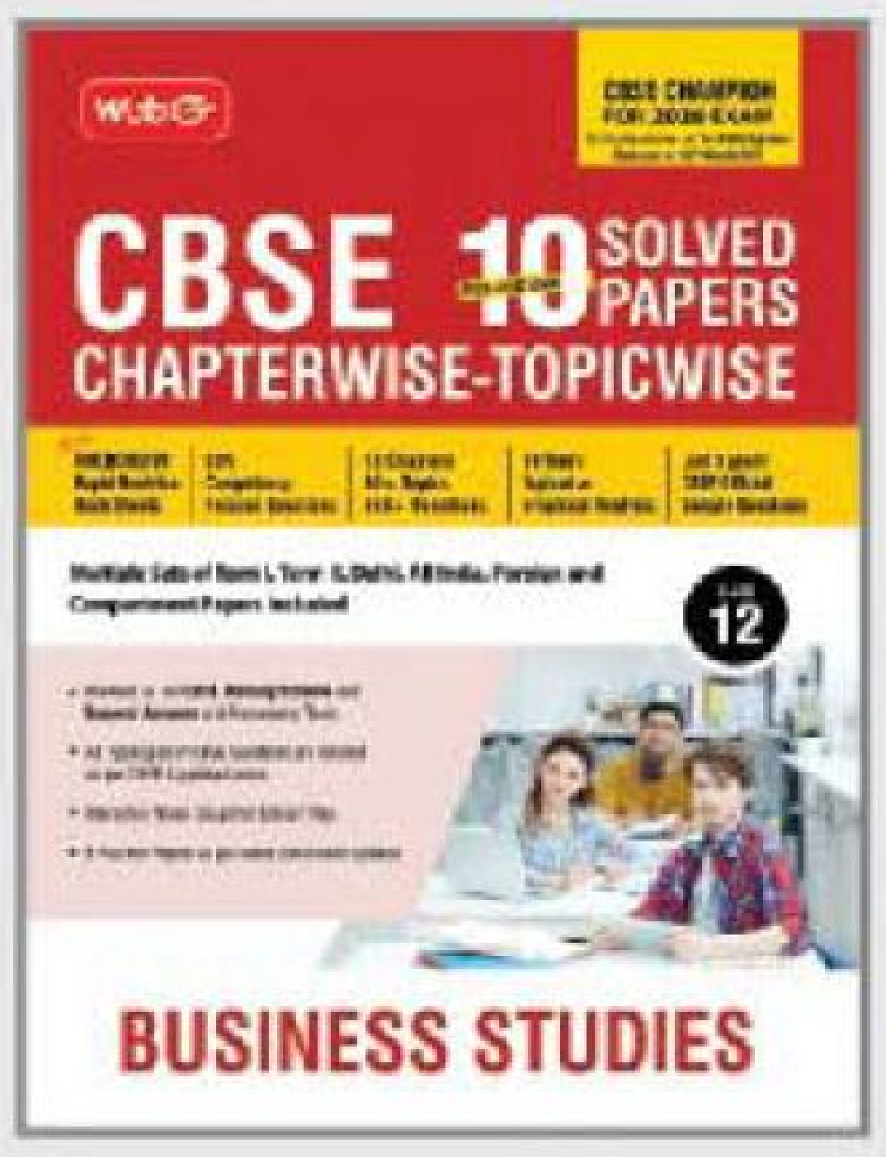
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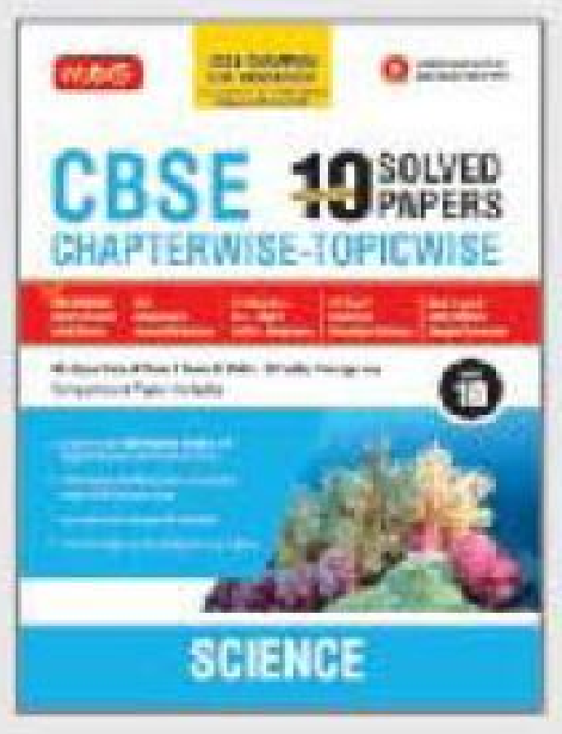
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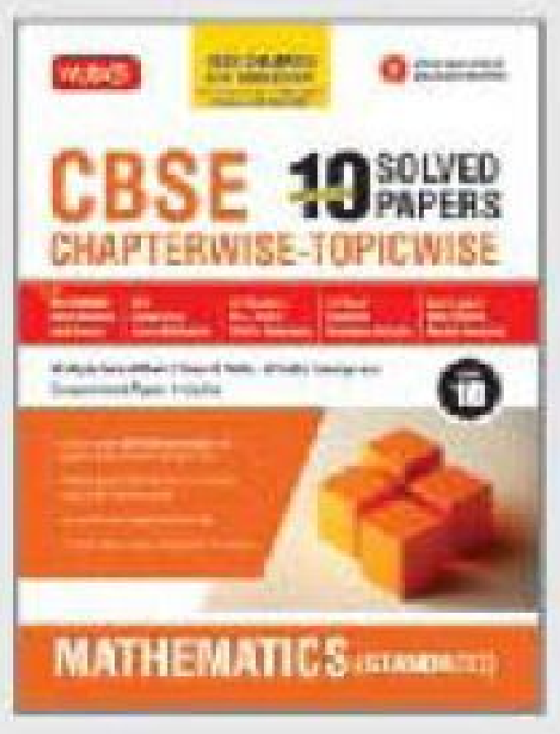
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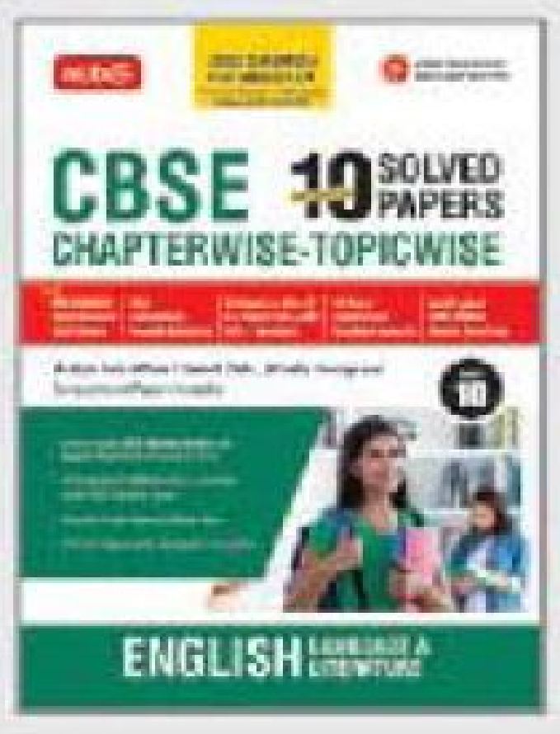
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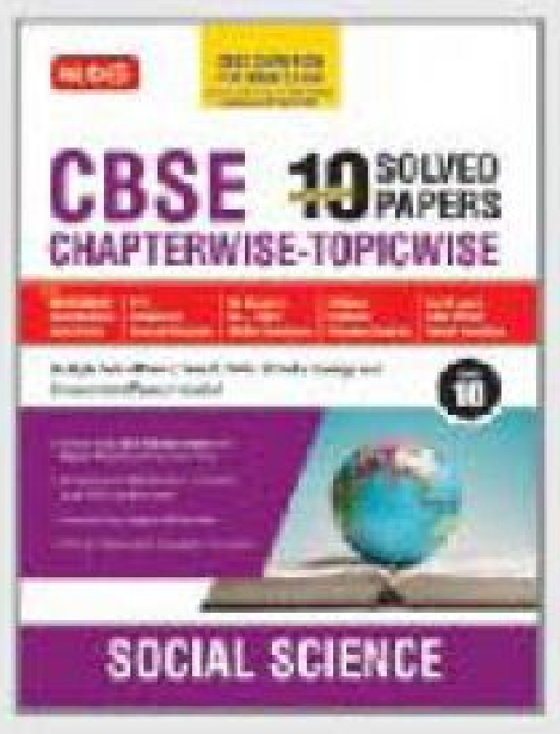
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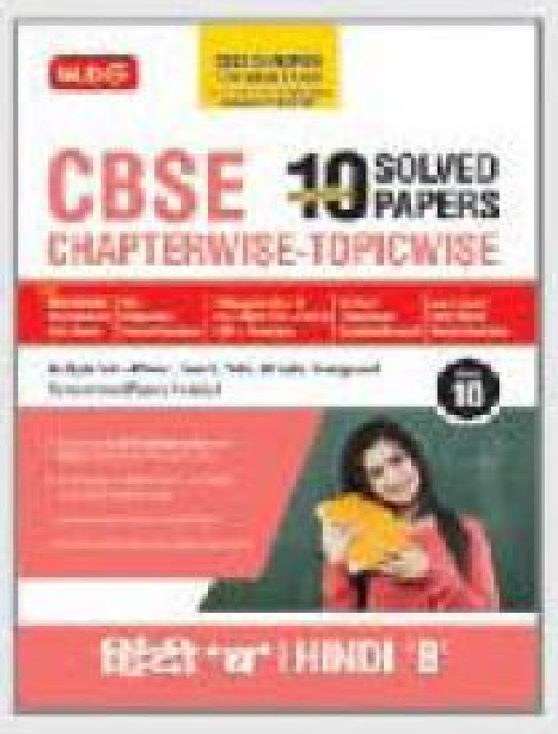
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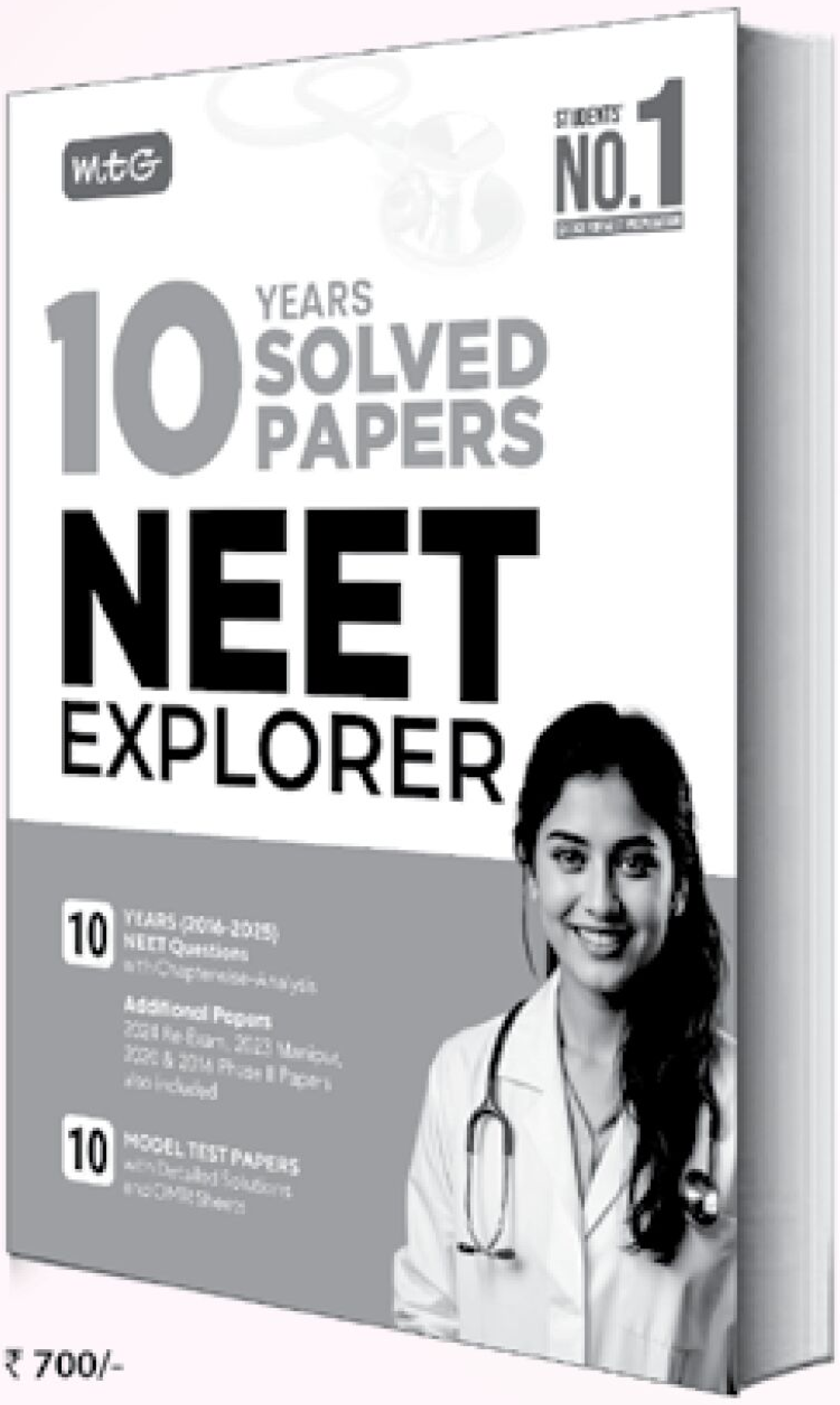
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Class XI

BIO Digest

This article covers high yield facts of the given topic.

Morphology of Flowering Plants

- Plant morphology (Gk. *morphe*-form, *logos*-study) is the branch of botany that deals with the study of forms and features of different plant organs like roots, stems, leaves, flowers, fruits, seeds, etc.
- A flowering plant has a long, cylindrical, unbranched or branched axis that bears a number of lateral appendages. Plant axis is differentiated into an **underground root system** and an **above ground shoot system**.
- Flowering plants contain vegetative parts (*i.e.*, root, stem and leaves) and reproductive parts, (*i.e.*, flowers, fruits and seeds).
- Plants can be classified on the basis of height and nature of stem (**herbs**, **shrubs**, and **trees**), life span (**annuals**, **biennials** and **perennials**) and frequency of flowering or fruiting (**monocarpic** and **polycarpic**).

MORPHOLOGY OF ROOT

- The root is typically a non-green, underground, descending portion of the plant axis which gives rise to similar types of endogenous lateral branches and does not possess nodes and internodes. They are positively geotropic, positively hydrotropic and negatively phototropic.
- A typical root consists of **five major zones** :
  - (i) **Root cap -** It covers the root apex and protects the young growing cells of the apical region.
  - (ii) **Meristematic zone -** It is present just above the root cap and made up of compact cells having dense protoplasm with large nucleus.
  - (iii) **Region of cell elongation -** It is situated above the meristematic zone. Here the cells elongate rapidly and increase the length of the root.
  - (iv) **Root hair zone** or **zone of differentiation -** Here different types of primary tissues differentiate. Unicellular and ephemeral root hairs are formed from the epidermal cells in this zone.
  - (v) **Zone of mature cells-** Constitutes the major portion of root, where cells do not undergo any further change.
- There are three types of root systems occurring in plants: **tap root system**, **fibrous root system** and **adventitious root system**. A comparative account between the three is summarised in the given table.

Table: **Comparison between tap root system, fibrous root system and adventitious root system**

	Tap root system	Fibrous root system	Adventitious root system
(i)	It is formed from the radicle of the embryo.	It is formed in place of tap root system at the base of main stem.	It may develop from any part of the plant other than radicle.

(ii)	It is always underground.	It is always underground.	It may be underground or aerial.
(iii)	It consists of a single primary (main) root.	Primary root is short lived. Instead underground roots arise in groups from base of stem.	Primary root is absent and it consists of roots forming a cluster.
(iv)	Primary root produces distinct secondary roots, tertiary roots and rootlets in acropetal succession.	The main roots are of equal length and give off small branches. Main roots and their branches are thin and thread like.	The roots may be thick, thin or variously modified.
(v)	It may be surface or deep feeder, the deep feeder being the usual feature.	It is usually surface feeder.	It is usually surface feeder.
(vi)	It is commonly found in dicots. *E.g.*, mustard.	It is commonly found in monocots. *E.g.*, wheat.	It is found both in dicots and monocots. *E.g.*, grass, *Monstera*, banyan.

Modifications of Roots

- Primary functions of roots are anchorage (or fixation) of the plant and absorption of water and minerals from the soil for their transport to the shoot system. However, roots undergo morphological modifications to perform various functions such as food storage, mechanical support, etc., as discussed briefly in the given flow chart.

Modifications of Root

Tap root system

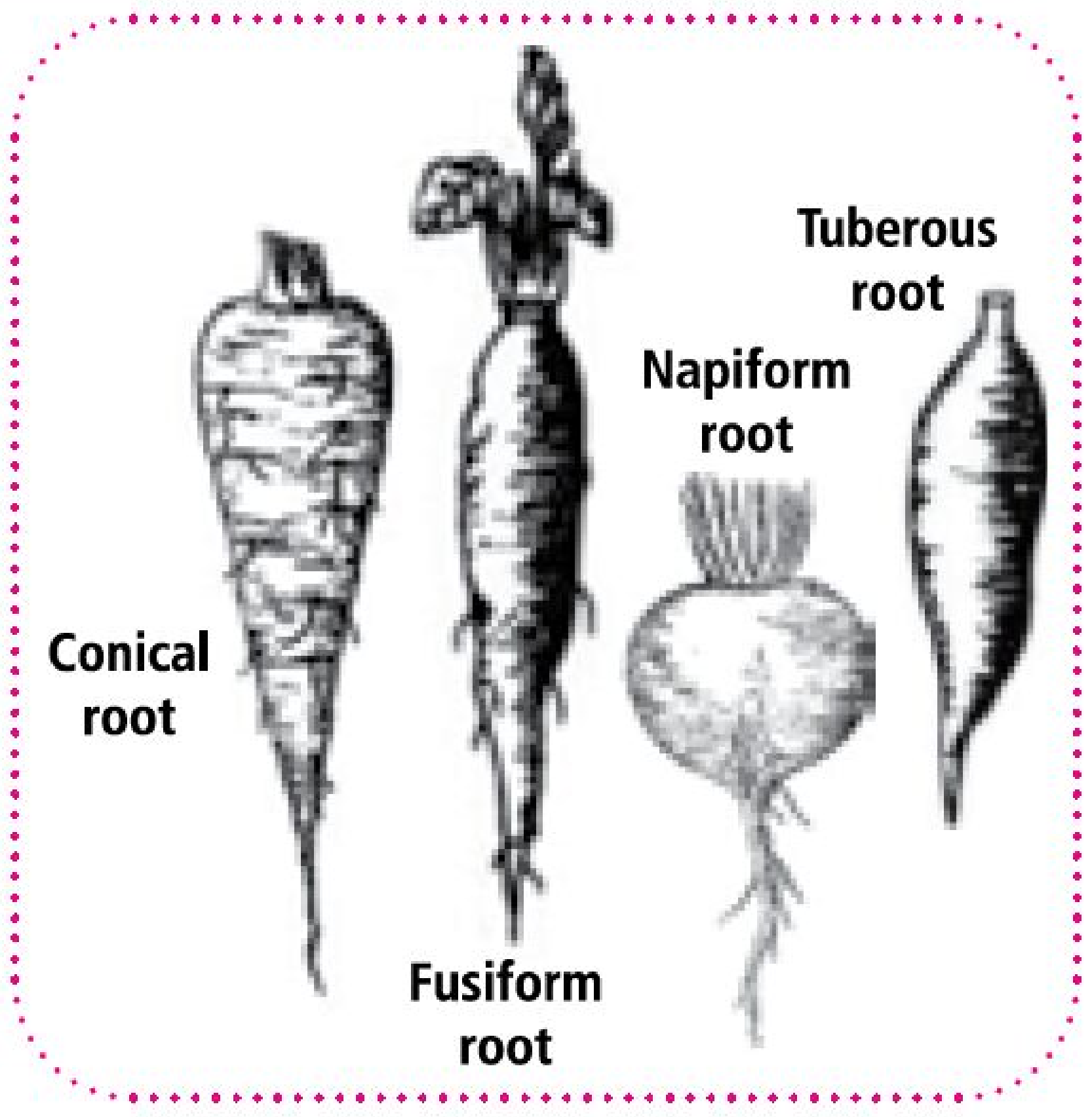
For storage of food

(i) Fusiform, swollen in the middle, and tapers towards both ends, *e.g.*, radish.

(ii) Napiform, swollen at base, almost spherical and suddenly tapers towards apex, *e.g.*, turnip, beet.

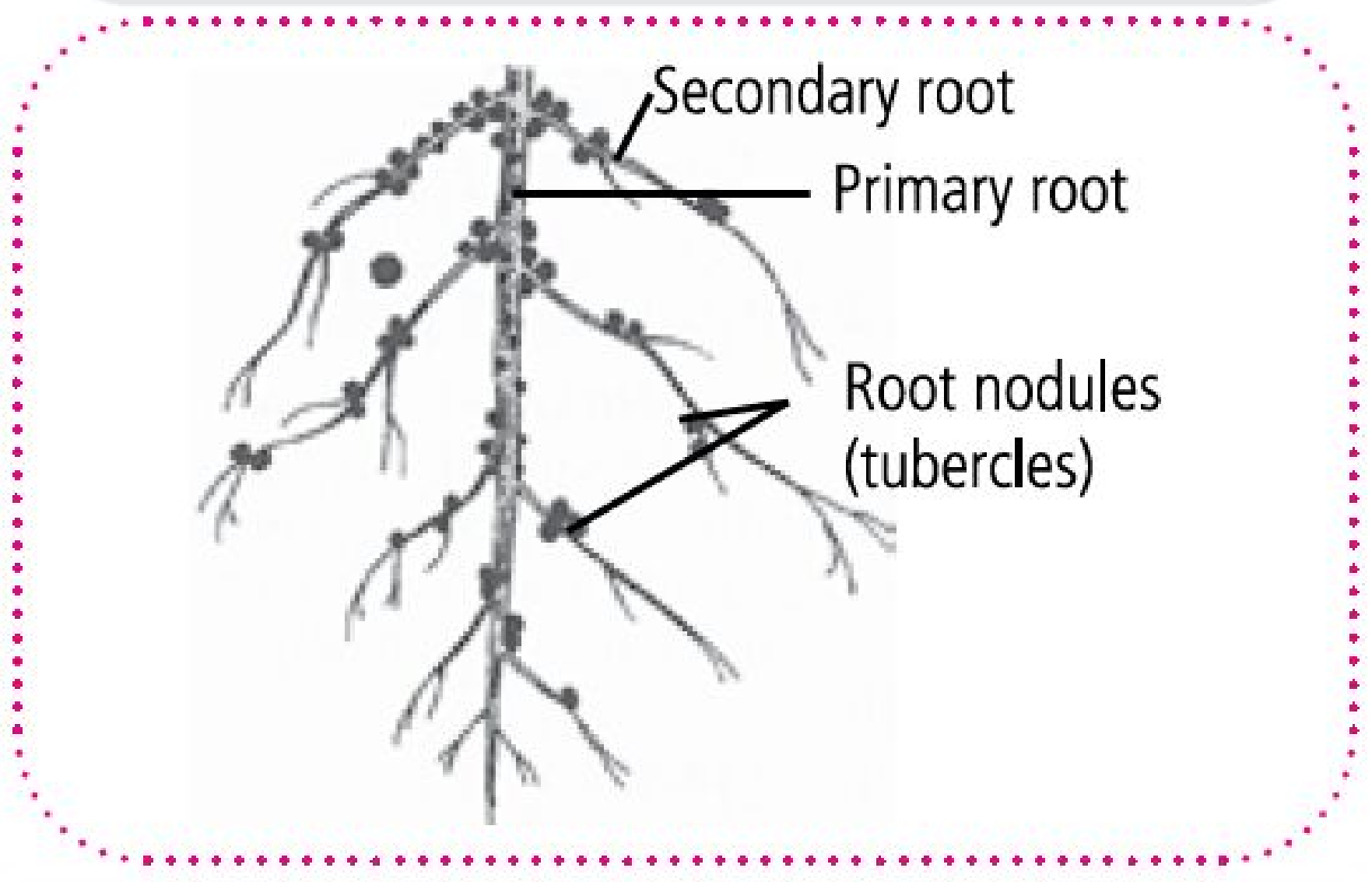
(iii) Conical, broad at base, and gradually tapers towards apex, *e.g.*, carrot.

(iv) Tuberous or **tubercular,** swollen, and without any definite shape, *e.g.*, *Mirabilis*.



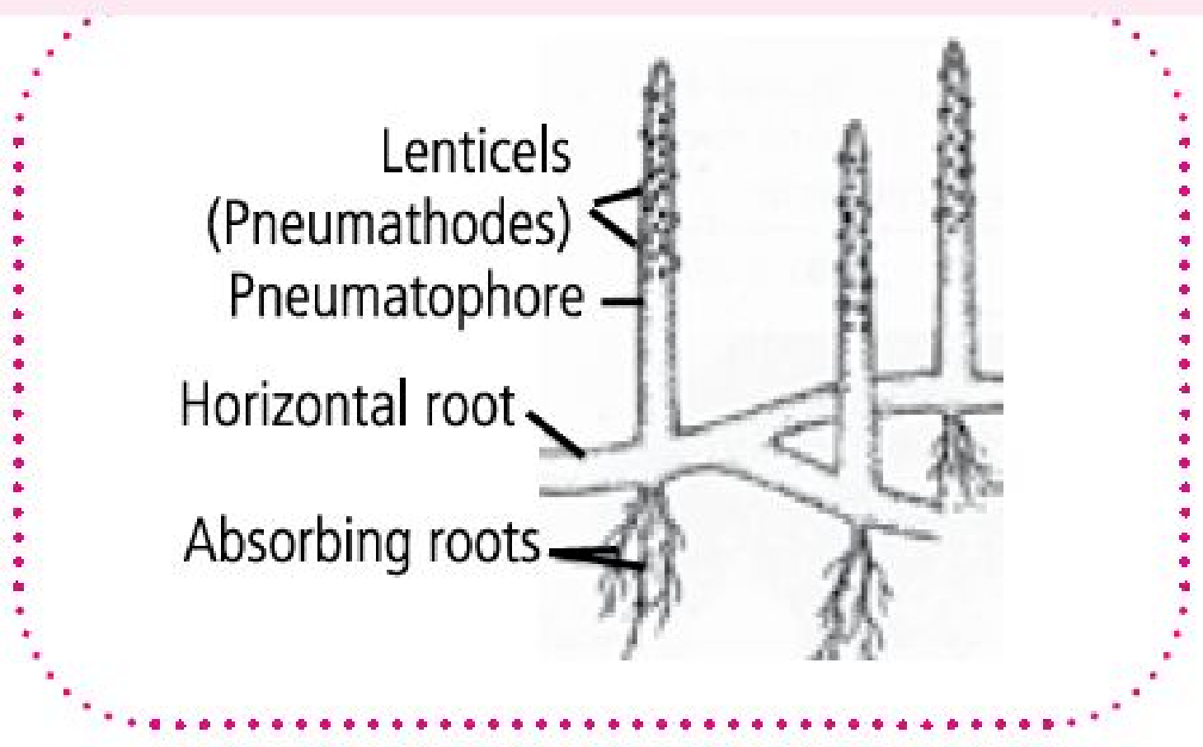
Nodulated (Tuberculate)

Root nodules are present on the roots and their branches which help to perform biological N_2-fixation. *e.g.*, leguminous plants.



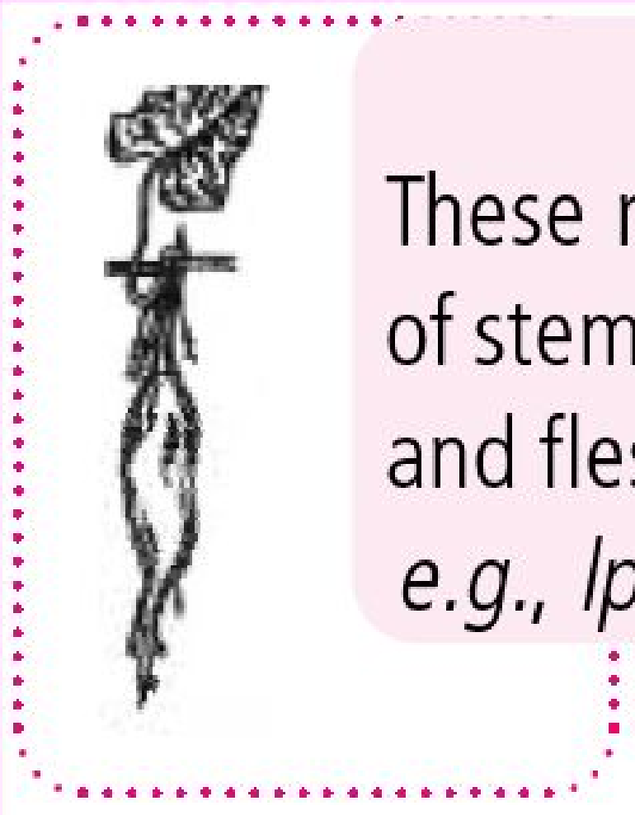
Pneumatophores (Respiratory roots)

Upright aerial roots which develop on the horizontal roots at short intervals. *e.g.*, mangrove plants such as *Avicennia*, *Heritiera*.



Adventitious root system

For storage of food

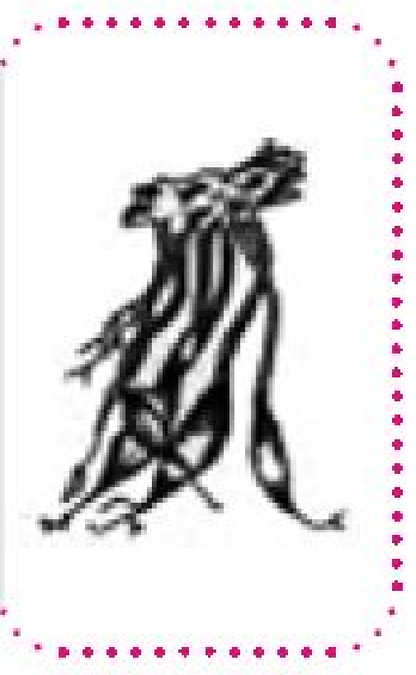


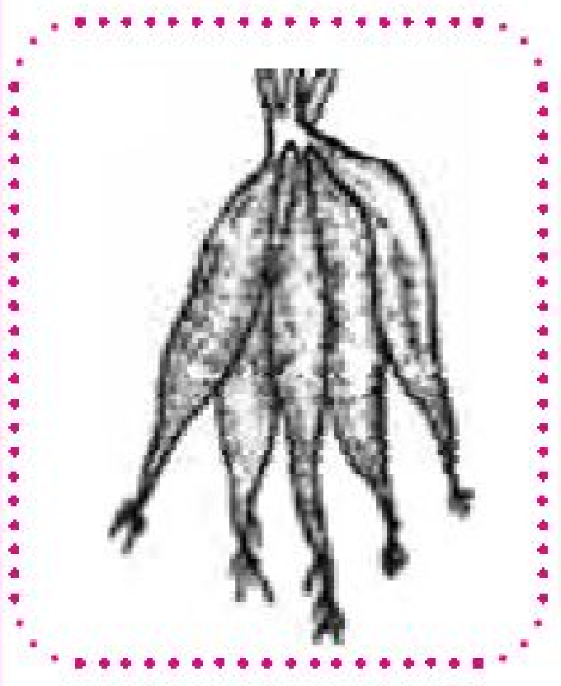
Tuberous

These roots arise from nodes of stem and become tuberous and fleshy for storage of food *e.g.*, *Ipomoea*

Nodulose

Swollen at tips, *e.g.*, *Curcuma amanda*.



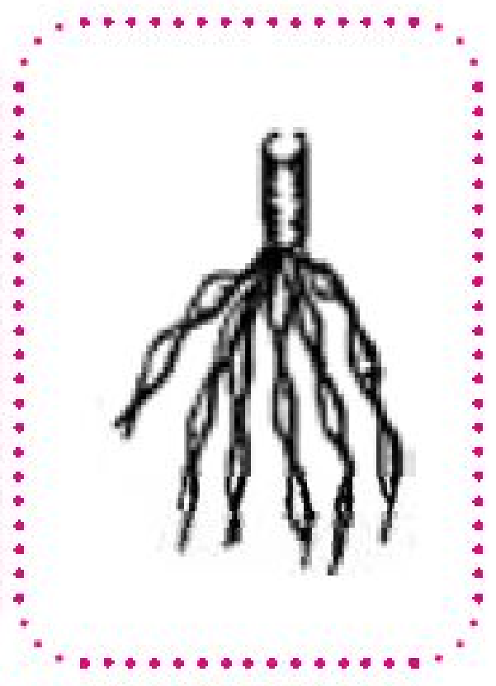


Fasciculated

Tuberous roots in clusters, *e.g.*, *Dahlia*, *Asparagus*.

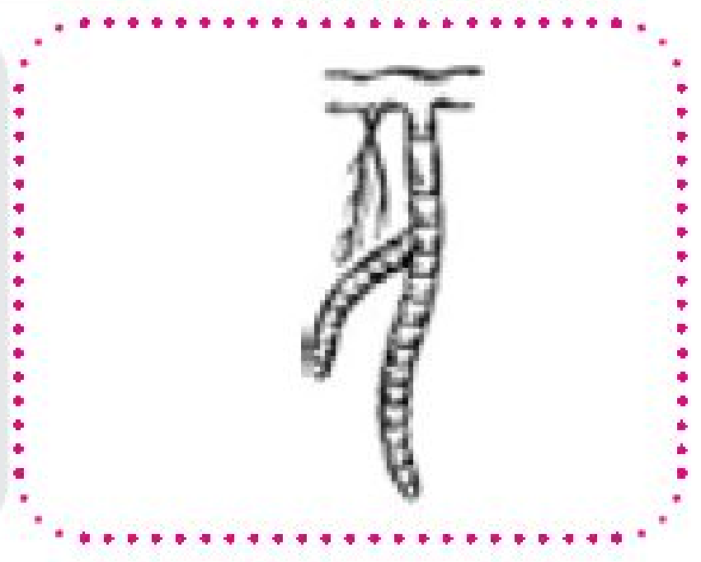
Moniliform

Swollen at regular intervals, *e.g.*, *Momordica*.



Annulated

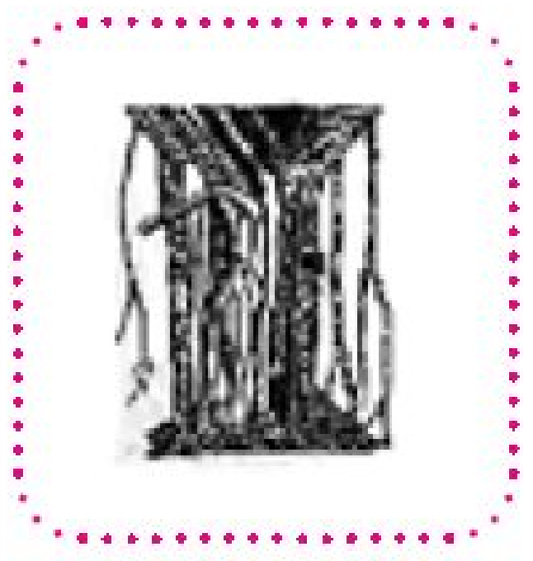
These roots arise from nodes of stem and become tuberous and fleshy for storage of food, *e.g.*, *Ipecac*



For mechanical support

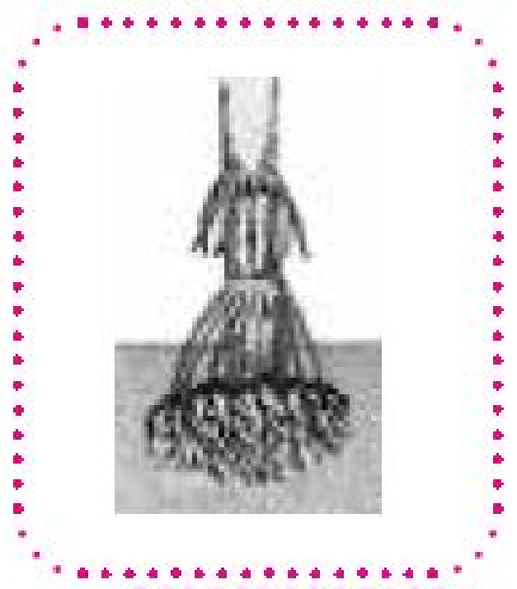
Prop

These are thick pillar-like roots which grow vertically downwards from horizontal stem branches. *e.g.*, *Ficus benghalensis*.



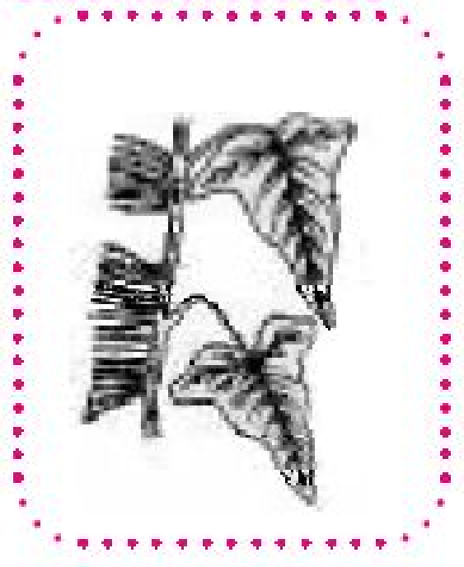
Stilt

The roots develop obliquely from basal nodes of stem, *e.g.*, maize, *Sorghum*, screw pine, etc.



Climbing or Clinging

These are non-absorptive roots found in climbers. They attach to their support firmly by forming claws, swollen discs etc. *e.g.*, *Hedera*, *Pothos*, etc.



For vital functions

Haustoria or sucking roots

They are parasitic and suck food, water and minerals from host plant, *e.g.*, *Cuscuta*, *Viscum*.

Floating

Spongy roots, help in buoyancy respiration, *e.g.*, *Jussiaea*

Reproductive

Adventitious roots develop buds that grow into new plants under favourable conditions, *e.g.*, *Dahlia*.

Assimilatory

Green, photosynthetic roots, *e.g.*, *Tinospora*.

Epiphytic

Thick, irregular roots hang down in air and absorb water from moist air *e.g.*, *Vanda*.

INTEXT PRACTICE QUESTIONS

1. **What are the primary functions performed by roots?**
2. **Give an example of moniliform root.**

- **Rootless plants** - Many plants growing in aquatic habitats do not possess roots because there is little requirement for absorption of water and mineral salts that is fulfilled by the general surface of plant itself. *e.g.*, *Wolffia, Utricularia, Ceratophyllum,* etc.
- **Plants that are all roots -** *Podostemon*, a hydrophytic plant, is made mainly of green (photosynthetic) flattened roots growing along rocky surface in shallow water which are fixed on rocks at intervals by holdfasts called **heptera**. However, these plants develop small flowering shoots at intervals on the root from time to time.

MORPHOLOGY OF STEM

- Stem is an ascending part of the plant body that develops from the plumule of the embryo and is usually negatively geotropic and positively phototropic.
- Stem grows by means of a terminal bud which represents a condensed immature or embryonic shoot possessing a growing point. The stem bears nodes and internodes.
- The buds are generally small in size. The largest bud is that of cabbage. According to their nature/structure buds can be **vegetative** (form leafy shoots only), **floral** (reproductive buds that develop into flowers) and **mixed** (both vegetative and floral branches).

WHO AM I ...

"I am the region of the stem where leaves are born."

...search me ☺

Branching Patterns of the Stem

- There are two main patterns of branching shown by the stem of a plant — dichotomous and lateral.
- In **dichotomous branching**, the growing point gets divided into two in the region of branching. The dichotomous branching is rare in angiosperms, *e.g.*, *Asclepia syriaca*, *Pandanus* (screw pine), *Hyphaene* (a palm).
- In **lateral branching**, the growing point does not get divided. Lateral branching is of two kinds: racemose and cymose.
- In racemose or monopodial branching the terminal bud continues its activity indefinitely. Lateral branches are borne in acropetal succession, *i.e.*, older towards the base and younger towards the tip, *e.g., Pinus, Eucalyptus*, etc.
- In cymose or sympodial branching, the terminal bud stops its activity after forming a small portion of axis. Further growth of axis is continued by one or more axillary branches. Cymose branching is of three types : **Uniparous** or **monochasial**, **biparous** or **dichasial** and **multiparous** or **polychasial**.

Modifications of Stem

- Stems of flowering plants attain diverse forms in order to perform various functions. These are of three types - **underground, aerial** and **subaerial.**
- **Underground modifications** : (a) **Stem tuber :** Swollen end of underground branch of main stem which possesses eyes/nodes, *e.g., Solanum tuberosum.* (b) **Sucker :** Formed from the nodes of underground stem and comes up obliquely in the form of leafy shoot, *e.g., Chrysanthemum,* mint. (c) **Rhizome :** A perennial fleshy underground stem having nodes and internodes, *e.g.*, ginger. (d) **Corm :** A subspherical, underground stem growing vertically inside soil, possesses adventitious roots at base and axillary buds in axils of scale leaves, *e.g., Colocasia.* (e) **Bulb :** Highly reduced disc like stem with numerous fleshy scale leaves covering a central terminal bud, adventitious roots arise from the under surface, *e.g.,* onion.
- **Aerial modifications**: (a) **Stem tendrils:** Fine, sensitive thread like structures which can coil around a support *e.g., Cucurbita* (b) **Phylloclades:** Flattened (*e.g., Opuntia*) or cylindrical (*e.g., Casuarina*), green, fleshy structures which have taken over the photosynthetic function of leaves. (c) **Cladodes (Cladophylls) :** Green stems of limited growth, generally one or two internodes long and perform the function of photosynthesis, *e.g., Asparagus* (one internode long). (d) **Thorns :** Stiff, hard pointed structures that perform defensive functions and check transpiration, *e.g., Citrus, Bougainvillea.*
- **Subaerial modifications** :

(a) **Runners :** Green, above ground horizontal branches which develop at the bases of erect shoots which are called crowns, *e.g., Oxalis*.

(b) **Stolons :** Elongated horizontal arched runners; lower portion of nodes gives rise to roots, *e.g., Fragaria* (strawberry).

(c) **Offset :** One internode long, short and thickened special horizontal branches, that develop a tuft or rosette of leaves at nodes, *e.g., Pistia, Eichhornia*.

MORPHOLOGY OF LEAF

- Leaf is a green lateral flattened outgrowth borne on the node of a stem or its branch and is characteristically photosynthetic. Leaves originate from the shoot meristem as leaf primordia and gradually enlarge. They are the most important vegetative organs of a plant as they synthesise food in them.

- A leaf consists of three parts – leaf base, petiole and lamina.
- **Leaf base** (hypopodium) is the lowermost part of the leaf and is joined to the node of the stem. In **pulvinate** leaves, leaf base is swollen and is called as **pulvinus;** leaf is easy to pluck due to weak attachment with stem, *e.g.*, gram. In some plants, leaf base consists of small appendages on both sides, these are called **stipules** which protect young leaves and axillary buds.
- **Petiole** (mesopodium) is a cylindrical or subcylindrical smooth or grooved stalk of the leaf which connects the lamina with the base. Leaf having petiole is called **petiolate** and the one without it is called **sessile.**
- **Lamina** (epipodium) or leaf blade is green, flattened part of leaf performing the important functions of photosynthesis, transpiration and respiration. Depending upon the incision of lamina, leaves can be **simple** (smooth or incised margins, incisions not deep upto midrib) or **compound** (incisions reach midrib dividing leaf into leaflets).
- **Venation** (arrangement of veins and veinlets on the lamina) is of two types (i) In **parallel venation,** the veins run parallel to each other, common in monocots and rare in dicots, *e.g., Eryngium*, etc. (ii) In **reticulate venation**, the main vein by forming a number of branches gives rise to a net like structure in the leaf, common in dicots and rare in monocots, *e.g., Smilax*, etc.
- **Phyllotaxy** (arrangement of leaves on the true stem and its branches) facilitates the leaves to obtain maximum light for photosynthesis. It may be of 3 types: (i) **Alternate** or **spiral :** Only one leaf is borne on a node and the leaves of the adjacent nodes roughly lie towards the opposite side, *e.g.*, shoe flower. (ii) **Opposite :** Each node gives rise to two leaves, arranged opposite to each other *e.g., Syzygium, Calotropis*. (iii) **Whorled :** More than two leaves are formed from each node, which are arranged in a whorl, *e.g., Alstonia, Nerium*.

Types of Leaves

- A leaf is said to be **simple**, when its lamina is entire or when incised, the incisions do not touch the midrib. When the incisions of the lamina reach up to the midrib breaking it into a number of leaflets, the leaf is called **compound**. A bud is present in the axil of petiole in both simple and compound leaves, but not in the axil of leaflets of the compound leaf.
- The compound leaves may be of two types : pinnately and palmately compound leaves.
- In a **pinnately compound leaf** a number of leaflets are present on a common axis, the **rachis**, which represents the midrib of the leaf as in neem. In **palmately compound leaves**, the leaflets are attached at a common point, *i.e.*, at the tip of petiole, as in silk cotton.

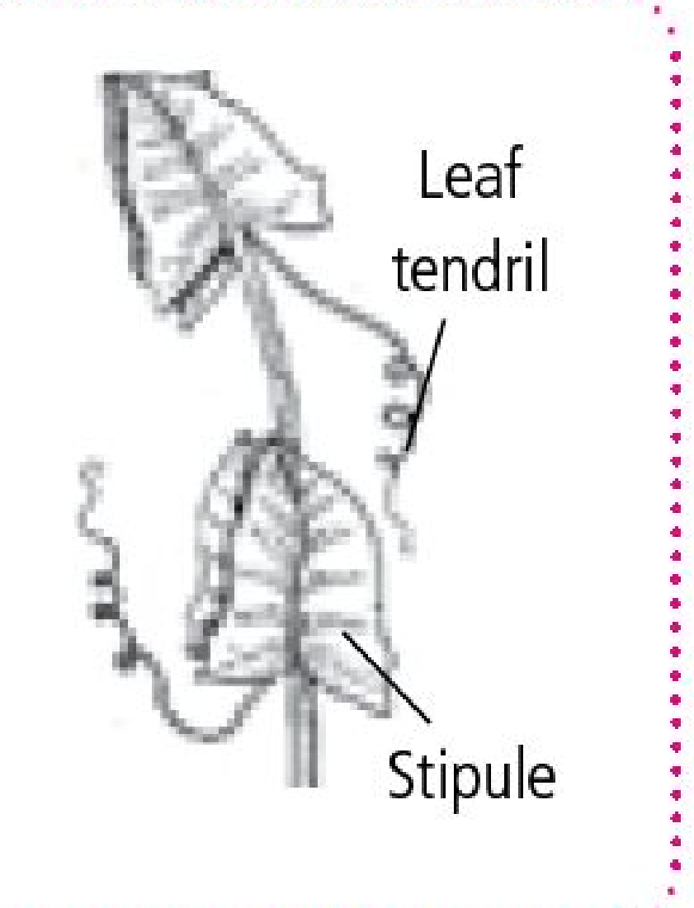
Modifications of Leaf

A leaf or its part is occasionally modified into specialised structures to perform some functions.

Modifications of leaf

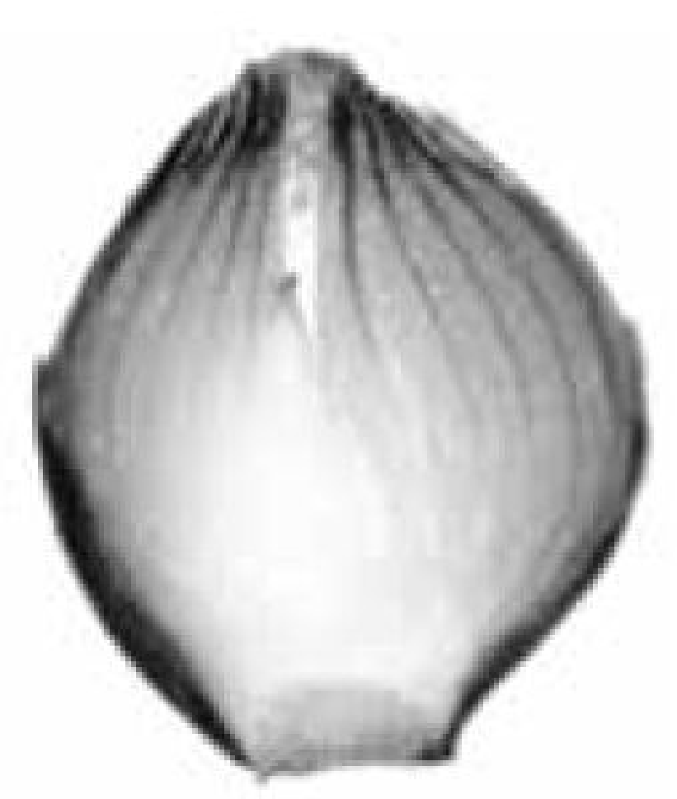
Leaf tendrils

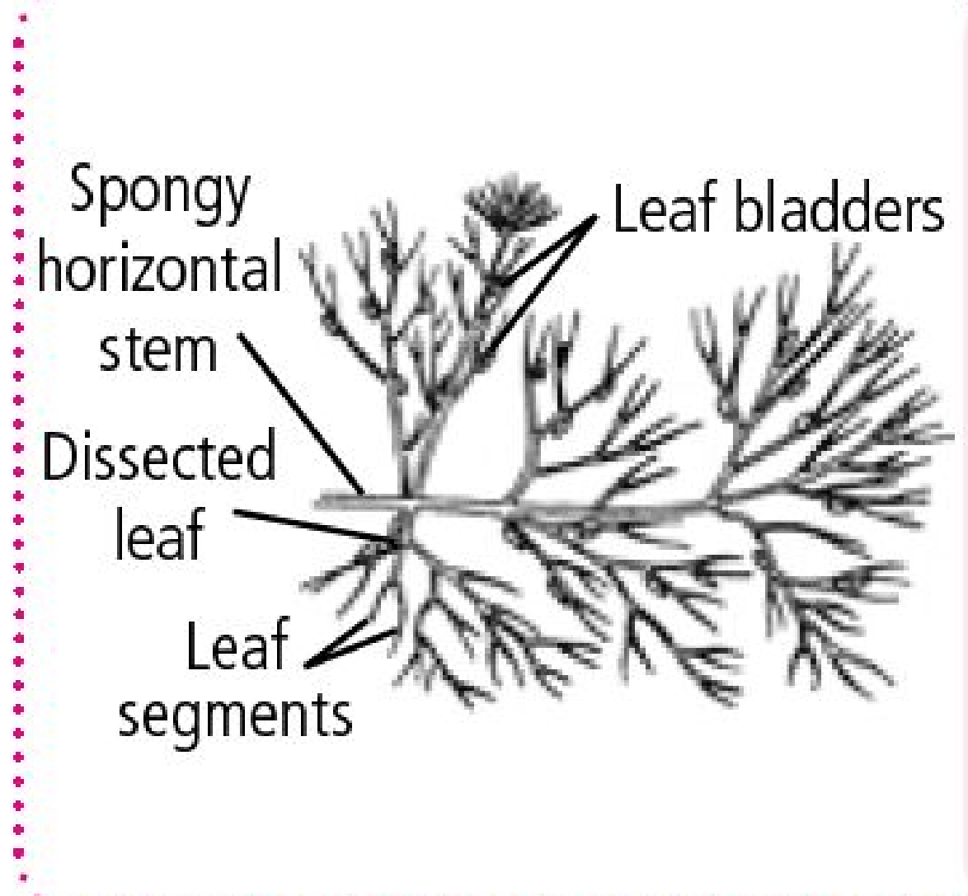
Tendrils are wire-like sensitive structures that help the plants in climbing by coiling around a support. These can be **whole leaf tendrils**, *e.g.*, Lathyrus aphaca (wild pea), **leaflet tendrils**, *e.g.*, Lathyrus odoratus (sweet pea), **petiolar tendrils**, *e.g.*, Tropaeolum majus (garden nusturtium), **Rachis tip tendrils**, *e.g.*, Lens culinaris (lentil), **leaf tip tendrils**, *e.g.*, Gloriosa superba (glory lily) and **stipular tendrils**, *e.g.*, Smilax.



Fleshy leaf

In some plant such as onion and garlic leaf becomes fleshy by storing food.



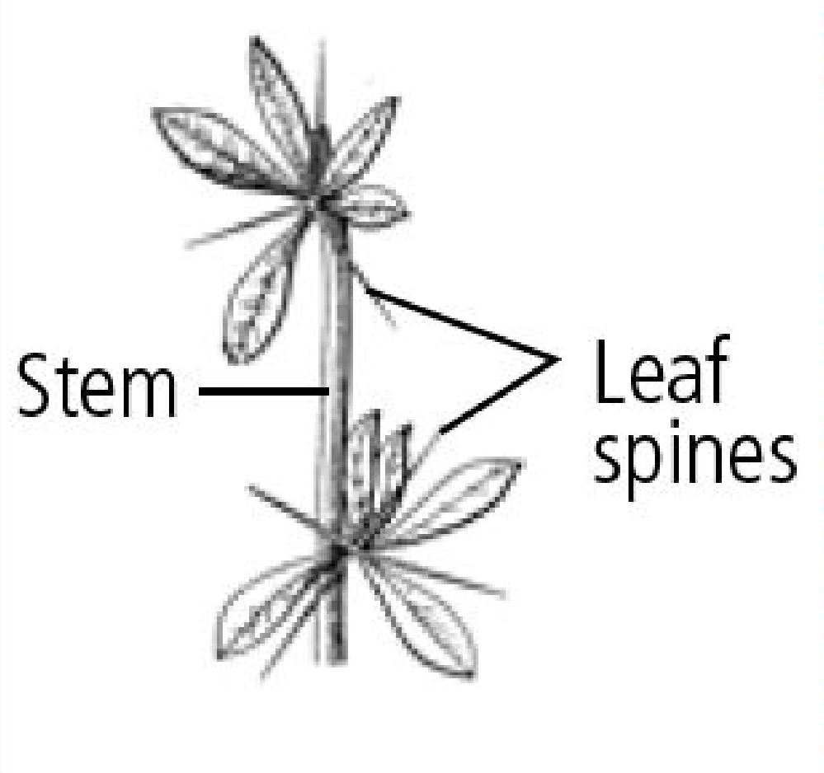


Leaf bladders

In insectivores like Utricularia and venus fly trap leaf is profusely dissected and some parts of it are modified into bladder like structures which help in catching insects.

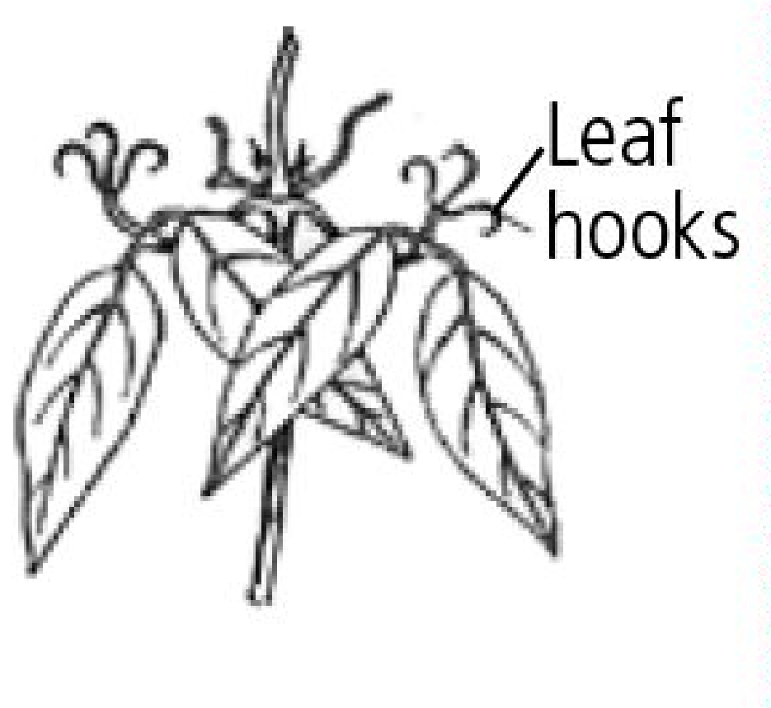
Leaf spines

Leaf gets modified into spine in order to protect the plant from grazing animals as well as reduce the rate of transpiration, *e.g.*, *Berberis*, *Acacia*, *Opuntia*.



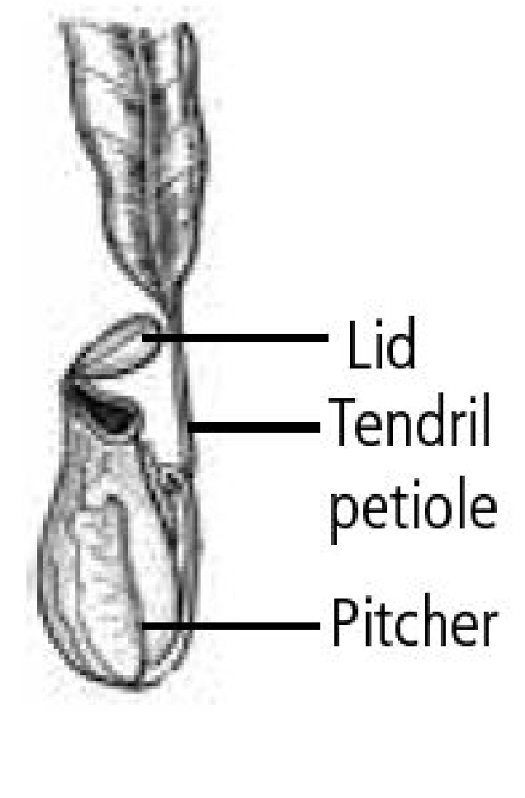
Leaflet hooks

The terminal leaflets of the compound leaves become transformed into three stiff claw-like and curved hooks. The hooks help the plant in climbing, *e.g.*, *Bignonia* unguis-cati.



Leaf pitcher

In some insectivorous plants, the leaves or their parts are modified into special **insect catching organs**. They catch and digest insects to fulfil their nitrogen requirements, *e.g.*, *Nepenthes*.



Succulent leaves

Succulent leaves occur in plants of saline and xerophytic habitats, *e.g., Aloe, Agave, Bryophyllum*.

INFLORESCENCE

- A group of flowers borne on a common axis is called inflorescence. The common axis bearing the flowers is called **peduncle**. Stalk of the individual flower is called **pedicel**. Flowers develop on the peduncle in the axils of bracts.
- Inflorescence can be racemose, cymose, mixed and specialised types.
- In **racemose type,** main axis of inflorescence has an indefinite (indeterminate) growth and it gives rise to (lateral or axillary) flowers in an **acropetal order** (*i.e.*, the youngest flower is at the apex while the oldest is at the base) or **centripetal order.** In **cymose** inflorescence, the growth of the main axis is limited as it is terminated by a flower, the arrangement of flowers is **basipetal** or **centrifugal.**

Types of Inflorescence

Racemose (Indefinite)
- Raceme *e.g.*, *Raphanus*
- Panicle *e.g.*, *Delonix*
- Spike *e.g.*, *Achyranthes*
- Catkin *e.g.*, *Morus*
- Spikelet *e.g.*, Wheat
- Spadix *e.g.*, *Colocasia*
- Corymb *e.g.*, *Iberis*
- Umbel *e.g.*, *Coriandrum*
- Capitulum *e.g.*, Sunflower

Cymose (Definite)
- Monochasial : Helicoid *e.g.*, *Drosera*
- Scorpioid : *e.g.*, *Ranunculus*
- Dichasial *e.g.*, *Clerodendrum*
- Polychasial *e.g.*, *Calotropis*
- Cymose head *e.g.*, *Anthocephalus*

Mixed
- Mixed spadix *e.g.*, Banana
- Thyrsus *e.g.*, Grapevine
- Corymb of capitula *e.g.*, *Ageratum*

Special
- Cyathium *e.g.*, *Euphorbia*
- Hypanthodium *e.g.*, *Ficus*
- Verticillaster *e.g.*, *Ocimum*

INTEXT PRACTICE QUESTIONS

3. What are cladodes?

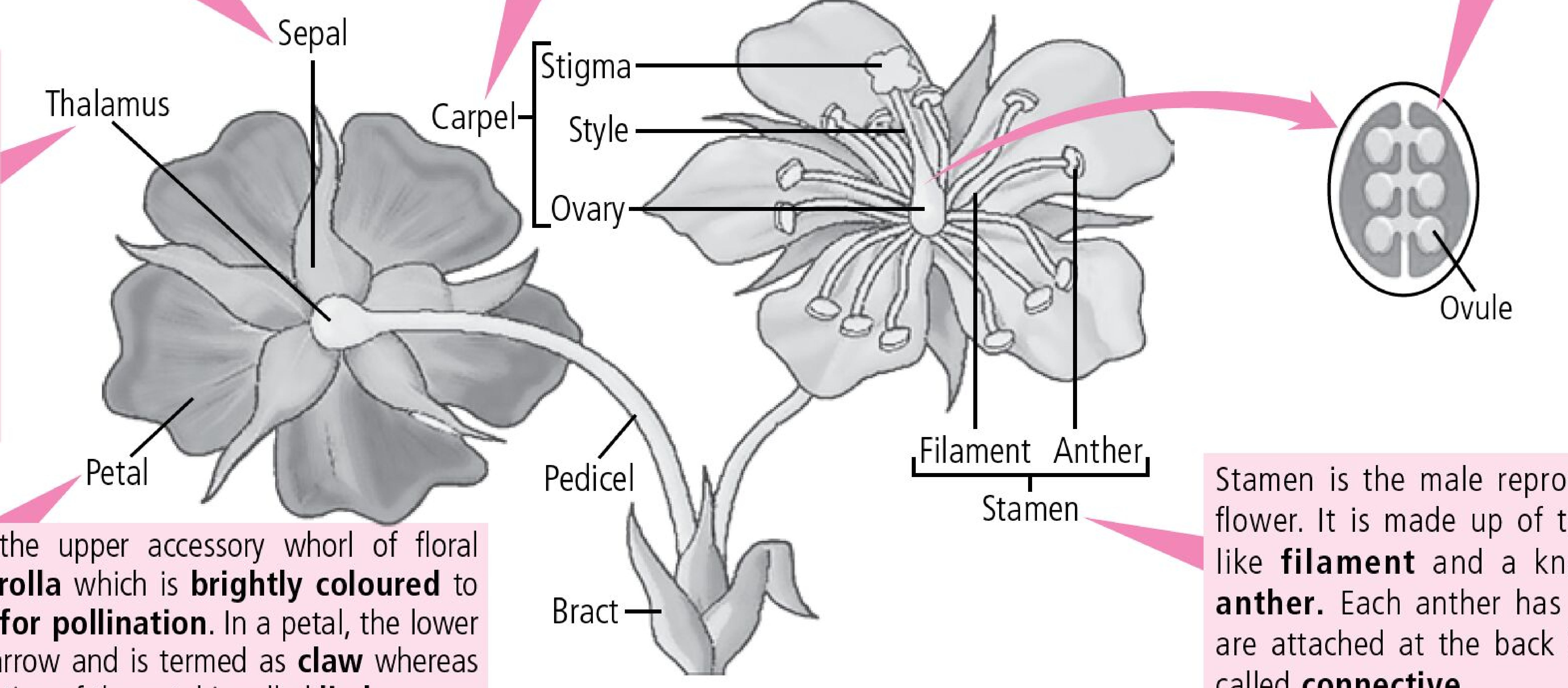
4. Define sporophylls.

5. What are the types of mixed inflorescence ? Give suitable examples.

FLOWER

It is a **specialised condensed shoot** meant for carrying out the **sexual reproduction**. It bears floral leaves and gives rise to seeds and fruits. The study of flowers is called **anthology**.

Solitary flowers can be terminal (*e.g.*, poppy) or axillary (*e.g.*, *Petunia*) in position.



They constitute the lower accessory whorl of mostly green, flattened or foliaceous floral organs called **calyx** which is mainly meant for **protecting** other floral parts in the bud condition.

Carpel or female reproductive part forms the innermost whorl of a flower. The free occurring unit of gynoecium is called pistil, which consists of basal swollen **ovary**, a stalk like **style** and a terminal receptive part called **stigma**.

Ovary has one or more chambers or loculi bearing ovules. **Ovules** are attached to cushion-like **placenta**.

Thalamus is a modified branch, that represents the axis of the floral whorls with undeveloped or suppressed internodes between them.

They constitute the upper accessory whorl of floral organs called **corolla** which is **brightly coloured** to **attract insects for pollination**. In a petal, the lower part is usually narrow and is termed as **claw** whereas the expanded portion of the petal is called **limb**.

Stamen is the male reproductive part of a flower. It is made up of two parts, a stalk like **filament** and a knob like terminal **anther.** Each anther has two lobes which are attached at the back by a sterile band called **connective.**

Fig. : Parts of a typical flower

- Flower bears floral leaves (sepals, petals, stamens and carpels), carries on sexual reproduction and gives rise to seeds and fruits. **Pedicel** is the stalk of flower. The tip of the pedicel is called **thalamus** (**torus** or **receptacle)** which is formed by the **condensation of internodes of the floral axis.**
- **Actinomorphic flowers** can be cut into two equal parts in any vertical plane, *e.g., Solanum*. **Zygomorphic flowers** can be cut into two equal parts in only one vertical plane, *e.g., Pisum*. **Asymmetric flowers** cannot be cut into two equal parts in any plane, *e.g., Canna*.
- The corolla can have free petals (polypetalous) or united petals (gamopetalous).
- The calyx may be with free sepals (polysepalous) or united sepals (gamosepalous).
- A flower with superior ovary is called **hypogynous,** *e.g.*, mustard, with inferior ovary is **epigynous**, *e.g.*, guava, with sub-inferior ovary is **perigynous**, *e.g.*, rose. In **pentamerous** flower each whorl especially calyx and corolla possesses 5 members. In **trimerous** and **tetramerous** flowers, each whorl possesses 3 and 4 members, respectively.
- The mode of arrangement of sepals or petals or tepals in relation to one another in a flower bud is called **aestivation.** When these units are not overlapping it is **valvate aestivation.** When out of the total number of units, one is completely out, one is completely in and the rest are in and out it is **imbricate aestivation.** In **descending imbricate** (vexillary) or papilionaceous **aestivation**, the standard petal is large and overlaps the two wing petals which in turn overlap the keel petal. In **ascending imbricate,** posterial petal is overlapped by two lateral ones which are being overlapped by two anterior ones**.** When of the total number of units, two are completely out, two are completely in and the fifth one is in and out, it is **quincuncial aestivation.** In **contorted** or **twisted aestivation** all units are in and out.
- On the basis of arrangement of more than one carpel ovary can be **Apocarpous** (carpel may be free as in lotus, rose) or **Syncarpous** (carpel may be fused as in mustard, tomato).
- On the basis of cohesion of their parts, stamens may be **monadelphous** (*e.g., Hibiscus, Abutilon*), **diadelphous** (*e.g., Pisum, Indigofera*), **polyadelphous** (*e.g., Citrus*), **syngenesious** (*e.g., Tridax, Helianthus*), **synandrous** (*e.g., Cucurbita, Coccinia*). When stamens adhere to either sepals or petals the condition is known as **episepalous** (*e.g, Quisqualis indica*) or **epipetalous,** (*e.g., Solanum*) respectively.

WHO AM I ...

"I am an accessory floral organ and cannot be distinguished as calyx or corolla."

...search me ☺

- **Placenta** refers to the parenchymatous cushion present inside the ovary where ovules are borne. Number, position, and arrangement of placentae inside an ovary is called **placentation.** It can be : **marginal** (placenta on ventral suture in monocarpellary ovary, *e.g.*, pea), **basal** (single placenta on floor of unilocular ovary, *e.g.*, sunflower), **axile** (placenta along axis, radial septa present, *e.g., Hibiscus*), **free central** (placenta along axis, no radial septa, *e.g., Dianthus*) and **parietal** (placenta on inner wall of syncarpous ovary, *e.g., Brassica*).

FRUIT

- True fruit or **eucarp** is a structure formed from ripened ovary under the influence of ripening ovules and is meant for protecting them. It consists of pericarp formed from the wall of the ovary and seeds formed from ovules. *E.g.*, mango, brinjal, tomato, cucumber, pea, etc. When in formation of a fruit other floral parts, (*e.g.*, thalamus, base of sepal, petals, etc.) participate, it is called false fruit or **pseudocarp**, *e.g.*, apple, pear etc.

  A fruit formed without fertilisation, *i.e.*, a seedless fruit is called **parthenocarp**, *e.g.*, banana.

Types of Fruit

Fruits can be classified as:

- **Simple fruits :** Develop from mono or multicarpellary, syncarpous ovary. They can be classified into dry and fleshy fruits.

(i) **Dry fruits** are further classified into (a) **Dehiscent: Pod** (*e.g.*, gram), **Follicle** (*e.g, Delphinium*), **Siliqua** (*e.g.*, Mustard), **Silicula** (*e.g., Iberis*), **Capsule** (*e.g.*, cotton). (b) **Indehiscent: Cypsela** (*e.g.*, marigold), **Caryopsis** (*e.g.*, maize), **Achene** (*e.g., Mirabilis*), **Samara** (*e.g., Holoptelia*), **Nut** (*e.g., Litchi*). (c) **Schizocarpic : Lomentum** (*e.g., Mimosa*), **Cremocarp** (*e.g.*, coriander), **Double samara** (*e.g., Acer*), **Regma** (*e.g., Ricinus*), **Carcerulus** (*e.g., Althaea*).

(ii) **Fleshy fruits** are **Drupe** (*e.g.*, mango), **Berry** (*e.g.*, Tomato), **Pepo** (*e.g.*, cucumber), **Pome** (*e.g.*, pear), **Hesperidium** (*e.g.*, orange), **Balausta** (*e.g.*, pomegranate).

- **Aggregate fruits :** Develop from multicarpellary apocarpous ovary. Types of aggregate fruits are **Etaerio of achenes** (*e.g.*, rose), **Etaerio of follicles** (*e.g., Michelia*), **Etaerio of drupes** (*e.g.*, raspberry), **Etaerio of berries** (*e.g.*, custard apple).
- **Composite fruits :** Develop from complete inflorescence and include **Sorosis** (*e.g.*, pineapple) and **Syconus** (*e.g.*, banyan).

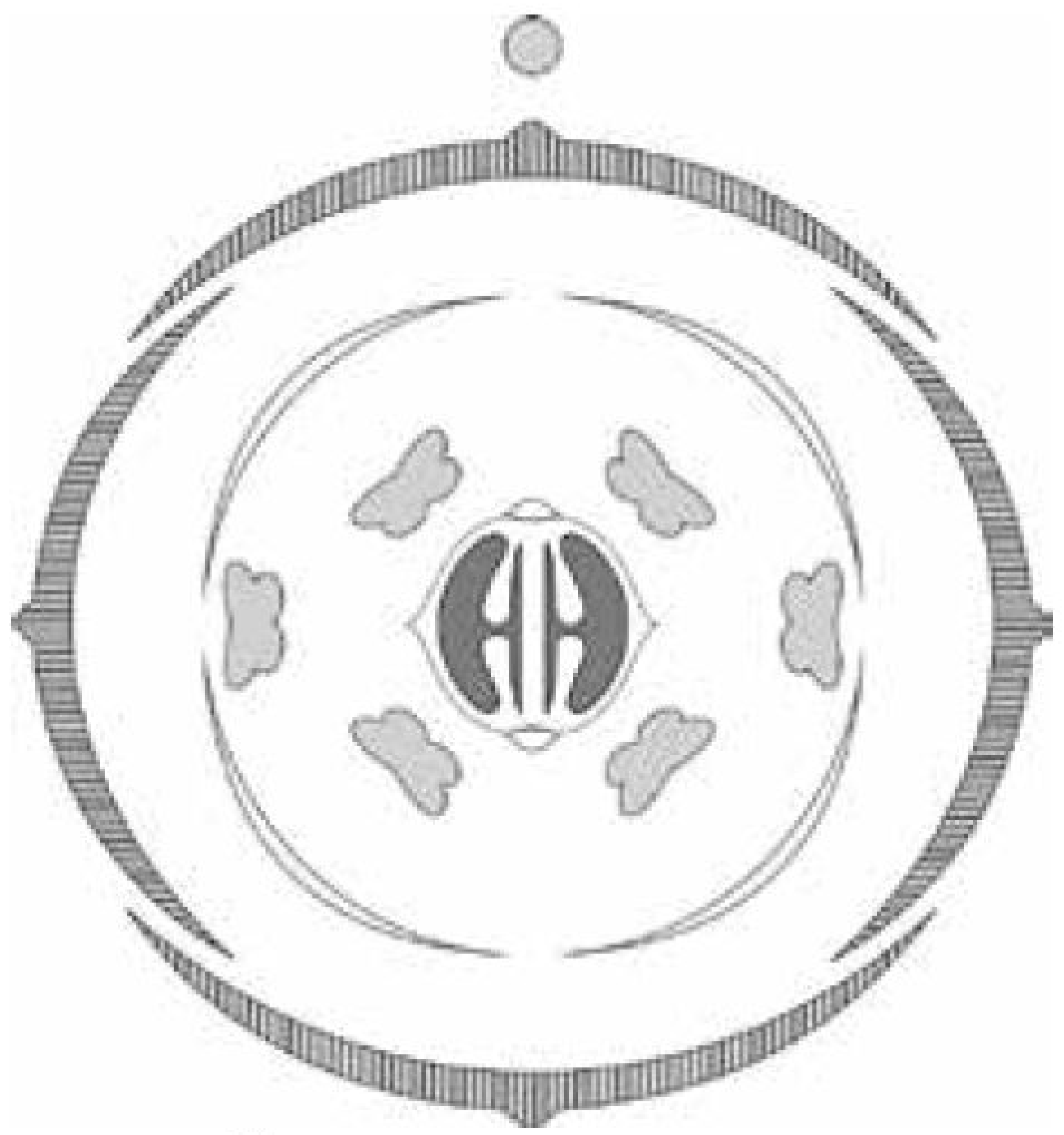
SEED

- Morphologically, seed is the integumented, mature, megasporangium which is developed from fertilised ovule and contains an embryo. A seed may have one or two coverings called **seed coats–** outer, thick, hard, leathery **testa** and the inner, thin, papery **tegmen.**

- With the help of a stalk called **funicle,** a seed is attached to the fruit wall and funicle is attached to seed at **hilum. Raphe** is the part of funicle that is fused with the seed coats or integuments. **Chalaza** is that region from which the seed coats originate. **Micropyle** is a small opening present at one end of the seed. **Kernel** is obtained by removing the seed coat and it mainly consists of the embryo. Kernel may also contain endosperm (reserve food), present in **endospermic or albuminous seeds** like cereals, castor, coconut, etc. In **exalbuminous or non-endospermic seeds** like gram, pea, mustard, etc., endosperm is fully consumed by the embryo. There is one cotyledon in monocots and two cotyledons in dicots. In some seeds (called perispermic seeds *e.g., Ricinus communis*), below the seed coat a very thin membrane is found over kernel called **perisperm** (the **persistent nucellus**). The embryonal axis is differentiated into radicle and plumule. In monocot seeds, the radicle is protected by a sheath called **coleorhiza** and the plumule is protected by **coleoptile.**

SEMI-TECHNICAL DESCRIPTION OF A TYPICAL FLOWERING PLANT

- **Floral formula** is the summarised account of the floral characters of a plant or a family represented by symbols, whereas **floral diagram** is a diagrammatic representation of the pooled up informations from transverse sections of the flower bud in relation to mother axis.
- To describe the characteristics of a flower in brief, a floral diagram and a floral formula are presented. The floral formula is represented by some symbols. In the floral formula, **Br** stands for bracteate, **K** stands for calyx, **C** for corolla, **P** for perianth, **A** for androecium and **G** for gynoecium, $\underline{G}$ for superior ovary and $\overline{G}$ forinferior ovary, ♂ for male, ♀ for female, ⚥ for bisexual plants, ⊕ for actinomorphic and **%** for zygomorphic nature of flower.
- Fusion is indicated by enclosing the figure



⊕ ⚥ $K_{2+2}\,C_4\,A_{2+4}\,\underline{G}_{(2)}$

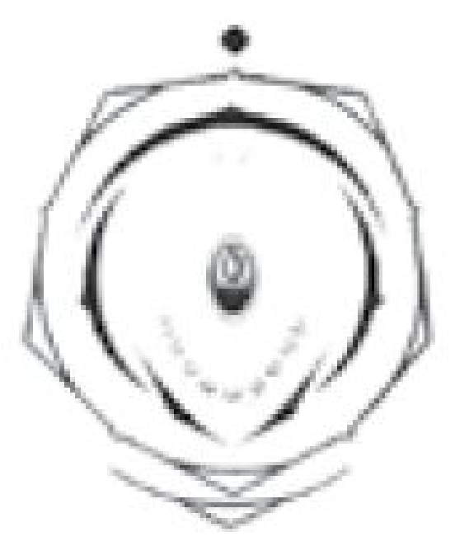
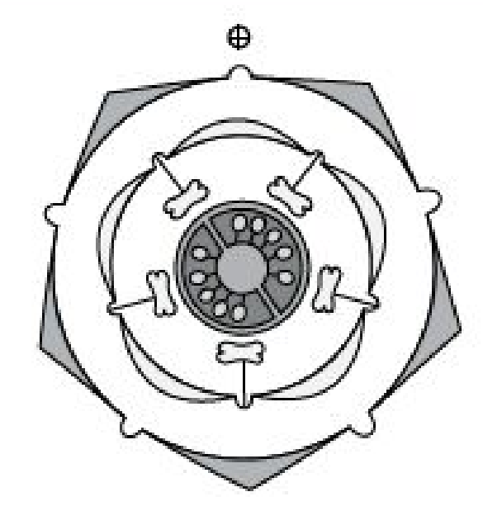
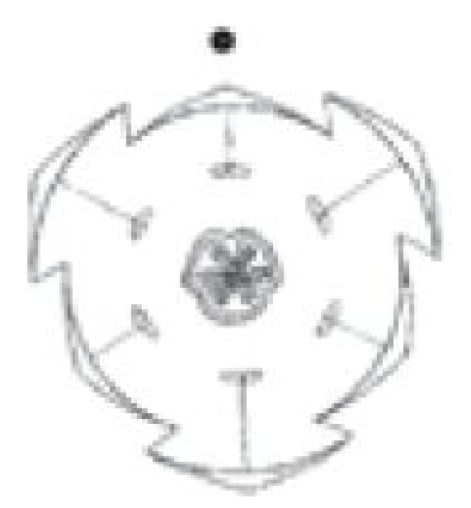
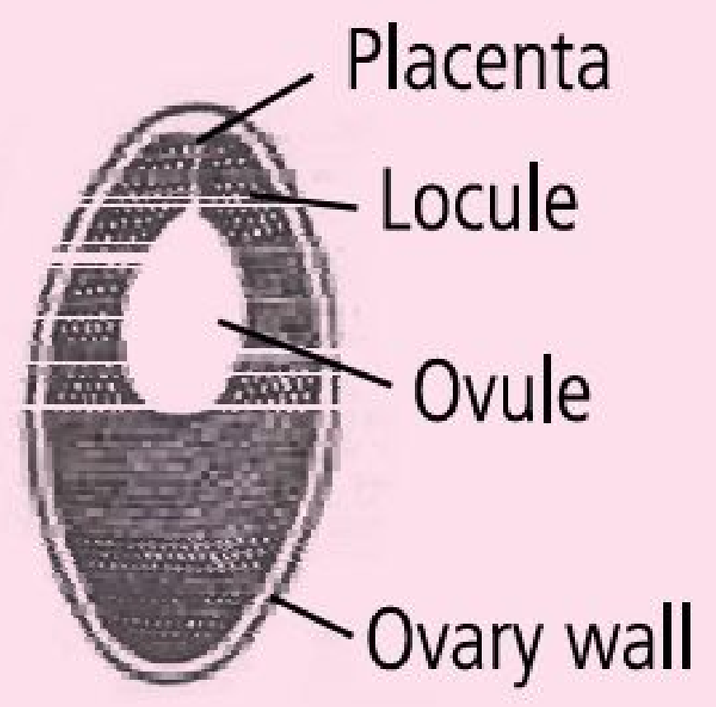
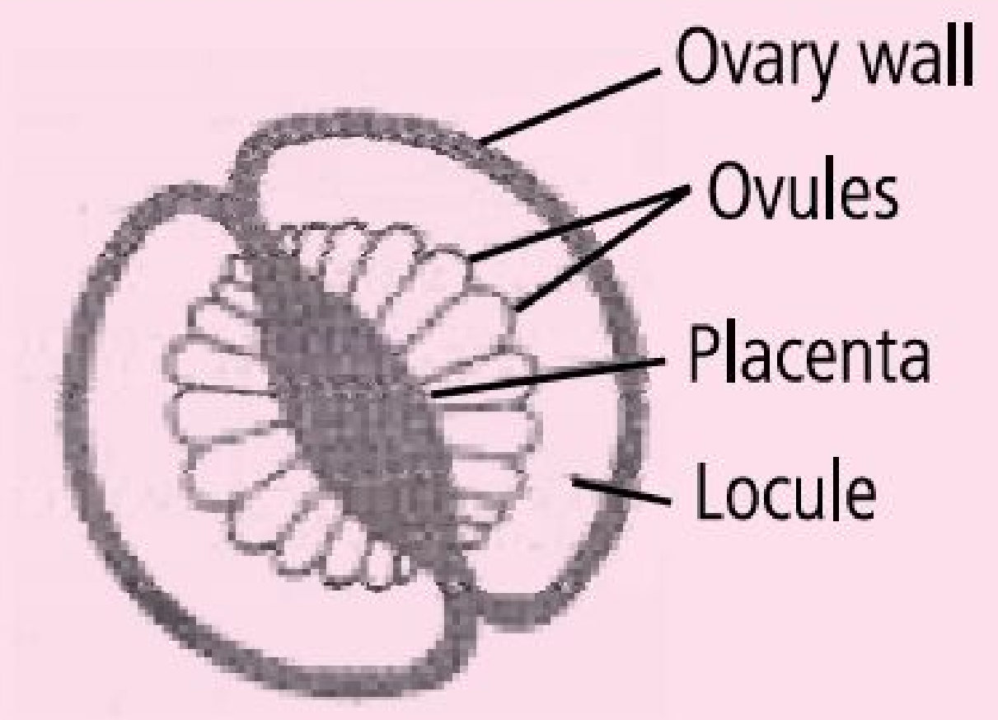
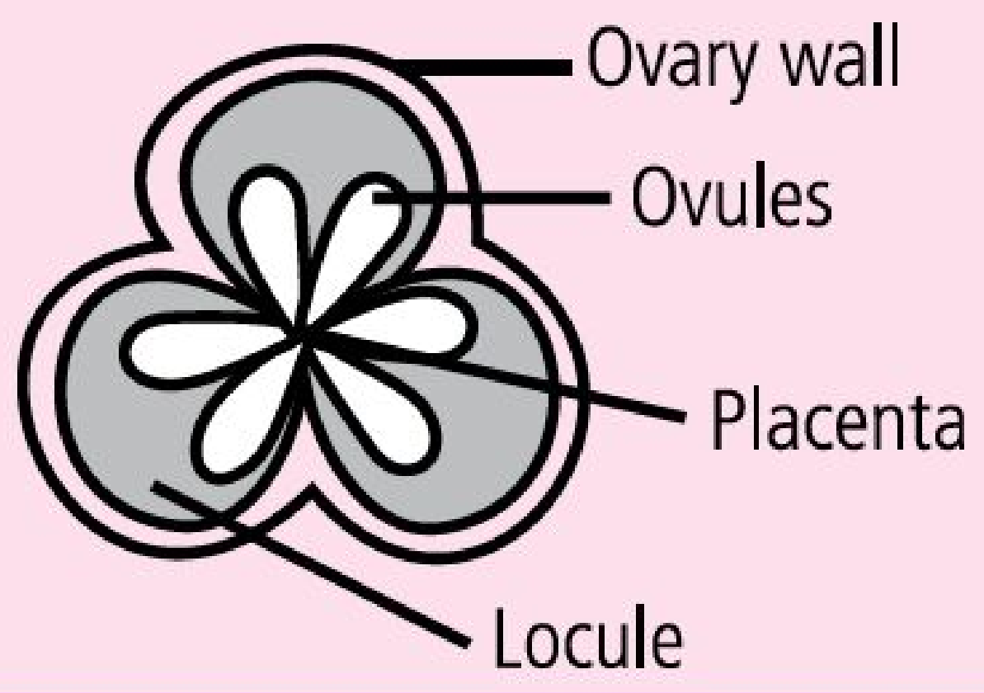
Fig.: Floral diagram with floral formula of Family Brassicaceae

DESCRIPTION OF SOME IMPORTANT ANGIOSPERM FAMILIES

- Various morphological features are used to describe a flowering plant. After describing various parts of plant, a floral diagram and a floral formula are presented.
- **Floral formula** is the summarised account of the floral characters of a plant or a family represented by symbols, whereas **floral diagram** is a diagrammatic representation of the pooled up information from transverse sections of the flower bud in relation to mother axis.

Table : **A comparative account of Families Fabaceae, Solanaceae and Liliaceae**

Characters	Fabaceae	Solanaceae	Liliaceae
Systematic position	Class – Dicotyledonae Subclass – Polypetalae Series – Calyciflorae Order – Rosales Family – Fabaceae	Class – Dicotyledonae Subclass – Gamopetalae Series – Bicarpellatae Order – Polymoniales Family – Solanaceae	Class – Monocotyledonae Series – Coronarieae Order – Liliales Family – Liliaceae
Vegetative characters	Trees, shrubs, herbs; roots with root nodules. Stem : erect or climber. Leaves : alternate, pinnately compound or simple; leaf base, pulvinate; stipulate; venation reticulate.	Plants mostly herbs, shrubs and rarely small trees. Stem : herbaceous (rarely woody) aerial, erect, cylindrical, branched, solid or hollows, hairy or glabrous. Leaves : alternate, simple, rarely pinnately compound, exstipulate; venation reticulate.	Perennial herbs with underground bulbs/corms/rhizomes Leaves : mostly basal, alternate linear, exstipulate with parallel venation
Inflorescence	Raceme or spike (panicle in *Dalbergia*)	Axillary or extra-axillary cyme, rarely solitary axillary (*Petunia*) or terminal (*Datura*)	Racemose, sometimes solitary or umbellate condensed cymes

Flower	Bisexual, zygomorphic, bracteate or ebracteate, pedicellate or sessile, perigynous or occasionally hypogynous, pentamerous	Bisexual, actinomorphic, ebracteate or bracteate, pedicellate, hypogynous, pentamerous, cyclic	Bisexual, actinomorphic, zygomorphic in few cases, bracteate or ebracteate, pedicellate, complete or incomplete, unisexual in *Ruscus* and *Smilax*, hypogynous, generally pentacyclic, trimerous
Calyx	Sepals five, gamosepalous, valvate or imbricate aestivation, usually campanulate	Sepals five, gamosepalous, valvate aestivation, persistent, accrescent (*Physalis*), campanulate or tubular, hairy	**Perianth :** Tepals six (3 + 3), often united into tube, valvate or imbricate aestivation, sepaloid or petalloid
Corolla	Petals five, polypetalous, papilionaceous, imbricate aestivation	Petals five, variously shaped, infundibulum, campanulate, rotate, united, valvate aestivation, plicate or folded like a fan in bud	
Androecium	Ten, usually diadelphous [(9) + 1], anthers dithecous, introrse, dehiscence longitudinal	Stamens five, epipetalous, filaments free, anthers bithecous, basifixed or dorsifixed, introrse, longitudinal or porous dehiscence.	Stamens six (3 + 3), free or monadelphous (*e.g.*, *Ruscus*), epiphyllous, basifixed, dorsifixed, or versatile anther, longitudinal dehiscence
Gynoecium	Ovary superior, monocarpellary, unilocular with many ovules, marginal placentation	Bicarpellary, syncarpous, ovary superior, bilocular, sometimes tetralocular due to false septum, placenta swollen with many ovules, axile placentation, ovary is obliquely placed	Tricarpellary, syncarpous, superior ovary, trilocular with 2-many ovules, axile placentation, rarely parietal, styles united or separate, stigma free or fused, trilobed
Fruit	Legume, rarely lomentum	Berry or capsule	Capsule, rarely berry
Seeds	One to many, non-endospermic	Many, endospermous	Endospermous
Floral formula	% ⚥ $K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\underline{G}_1$	$\oplus$⚥ $K_{(5)}\ \overset{\frown}{C_{(5)}} A_5\ \underline{G}_{(2)}$	Br$\oplus$⚥ $\overset{\frown}{P_{3+3 \text{ or } (3+3)} A_{3+3}}\ \underline{G}_{(3)}$
Economic importance	Pulses : *E.g.*, Gram, arhar, sem, moong, soybean Edible oil : *E.g.*, Soybean, groundnut Dye : *E.g.*, Indigofera Fodder : *E.g.*, *Sesbania*, *Trifolium* Ornamentals : *E.g.*, Lupin, sweet pea Medicine : *E.g.*, *Muliathi*	Food : *E.g.*, Tomato, brinjal, potato Spice : *E.g.*, Chilli Medicine : *E.g.*, Belladonna, *Ashwagandha* Fumigatory : *E.g.*, Tobacco Ornamentals : *E.g.*, *Petunia*	Ornamentals : *E.g.*, Tulip, *Gloriosa* Medicine : *E.g.*, *Aloe* Vegetables : *E.g.*, *Asparagus* Colchicines : *Colchicum autumnale*
Floral diagram			
T.S. Ovary			

Anatomy of Flowering Plants

- Plant anatomy (Gk. *ana*-up, tome-cutting) is the branch of science which deals with the study of gross internal structure of plant organs, as observed after section cutting.
- The first detailed account of internal structures of plant was published by an English physician **Nehemiah Grew** (1641-1712) in his book **"The Anatomy of Plants".** N.Grew is known as **'father of plant anatomy'.**

TISSUES

- A group of structurally similar or dissimilar cells that have a common origin and perform or help to perform a common function is called as a **tissue.** With the exception of some lower plants, the internal structures of most plants are complex and comprise of different types of tissues.
- On the basis of their ability to divide, plant tissues have been broadly classified into **two main types: meristematic tissues** and **permanent tissues.**

MERISTEMATIC TISSUES

- A meristematic tissue (or meristem) is a group of similar and immature cells that are preparing to divide or are in continuous state of division.
- Meristematic cells show few characteristics, such as (a) ability to grow and divide, (b) thin cellulosic walls, (c) isodiametric, rounded, oval or polygonal in shape (d) compactly arranged without intercellular spaces, (e) dense cytoplasm, prominent nucleus and (f) high metabolic rate, etc.
- On the **basis of origin**, meristems may be primary (origin from embryonic cells) or secondary (originated by dedifferentiation of permanent tissues). Apical, intercalary and fascicular meristems are **primary meristems** as they originate from the embryonic meristems or **promeristems.** They retain the meristematic nature throughout the plant life. Interfascicular cambium and cork cambium are **secondary meristems** since they originate as new meristems from the permanent tissues which have already undergone differentiation.
- They can be classified on the **basis of position** in plant body as :
  - (i) **Apical meristems :** They are present at the tips of stem, root and their branches. They lead to growth in length.
  - (ii) **Intercalary meristems :** They are derived from the apical meristems and have been separated from them by formation of permanent tissues in between. These help in elongation of the organs and are commonly found at the bases of leaves and above (*e.g.*, grasses) or below the nodes (*e.g.*, mint).
  - (iii) **Lateral meristems** occur on the sides and take part in increasing girth of the plant (secondary growth). The common examples are **fascicular vascular cambium** (primary meristem), **interfascicular cambium** and **cork cambium** or **phellogen.**

PERMANENT TISSUES

- Permanent tissues are formed as a result of division and differentiation of meristematic tissues.
- The cells of permanent tissues lose the capacity to divide and assume a definite shape, size and function, but in certain cases they may resume the meristematic activity.
- Permanent tissues are categorized into **three main types– simple tissues, complex tissues** and **special tissues/ secretory tissues.**
- A **simple permanent tissue** is made up of similar permanent cells that carry out the same function or similar set of functions. Simple permanent tissues are of three types:
  - (i) **Parenchyma :** It consists of thin-walled **living cells** which have intercellular spaces between them and their **cell wall** is made of cellulose and **calcium pectate.** It serves the functions of food storage, absorption, lateral conduction, photosynthesis, providing buoyancy, secretion, etc.

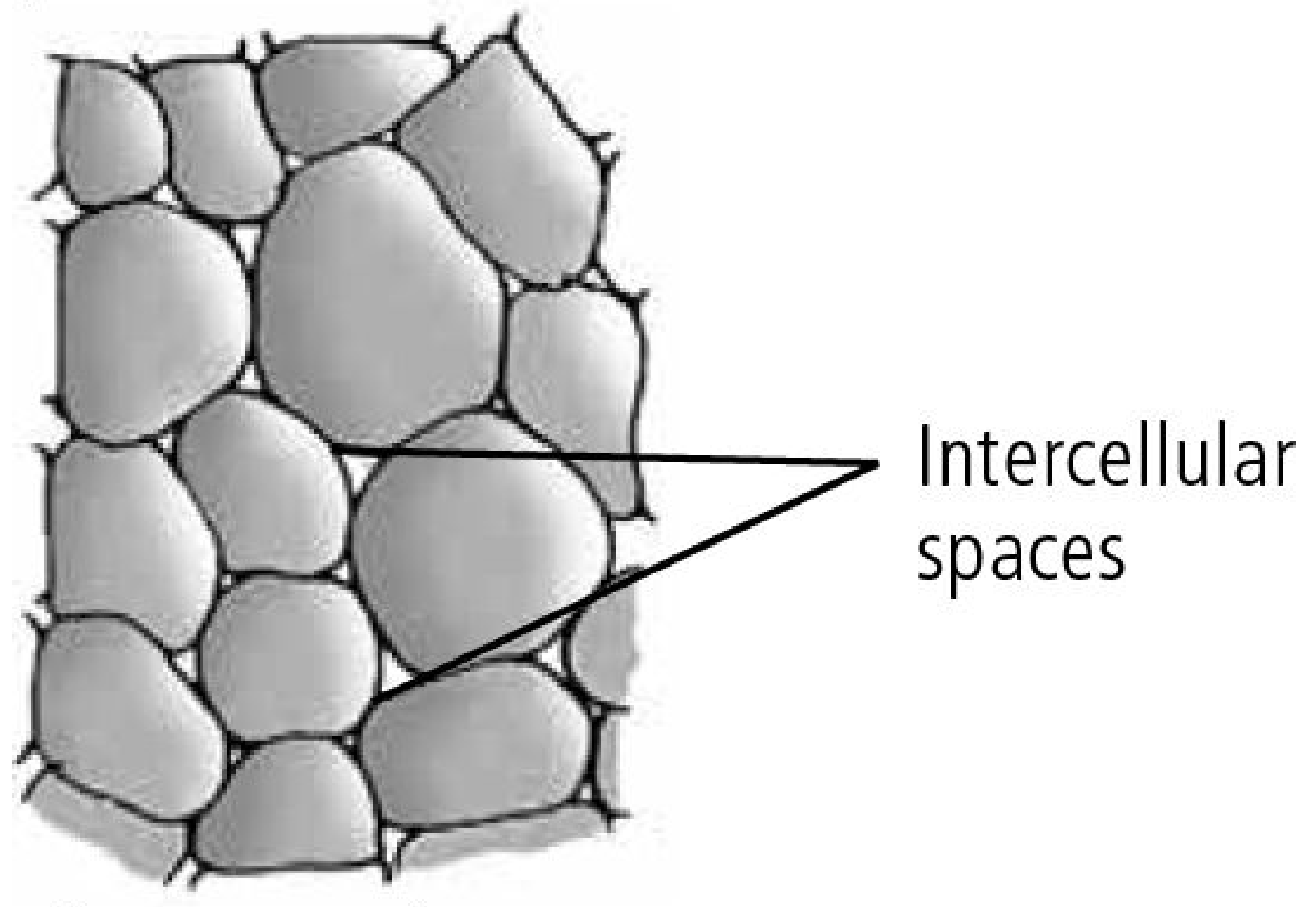


Fig.: Parenchyma

  - (ii) **Collenchyma** consists of refractile **non-lignified** living cells which possess **pectocellulose** thickenings in specific areas of their walls. It provides mechanical strength to young dicot stems, petioles and leaves and flexibility to the organs. It often contains chloroplasts for photosynthesis.

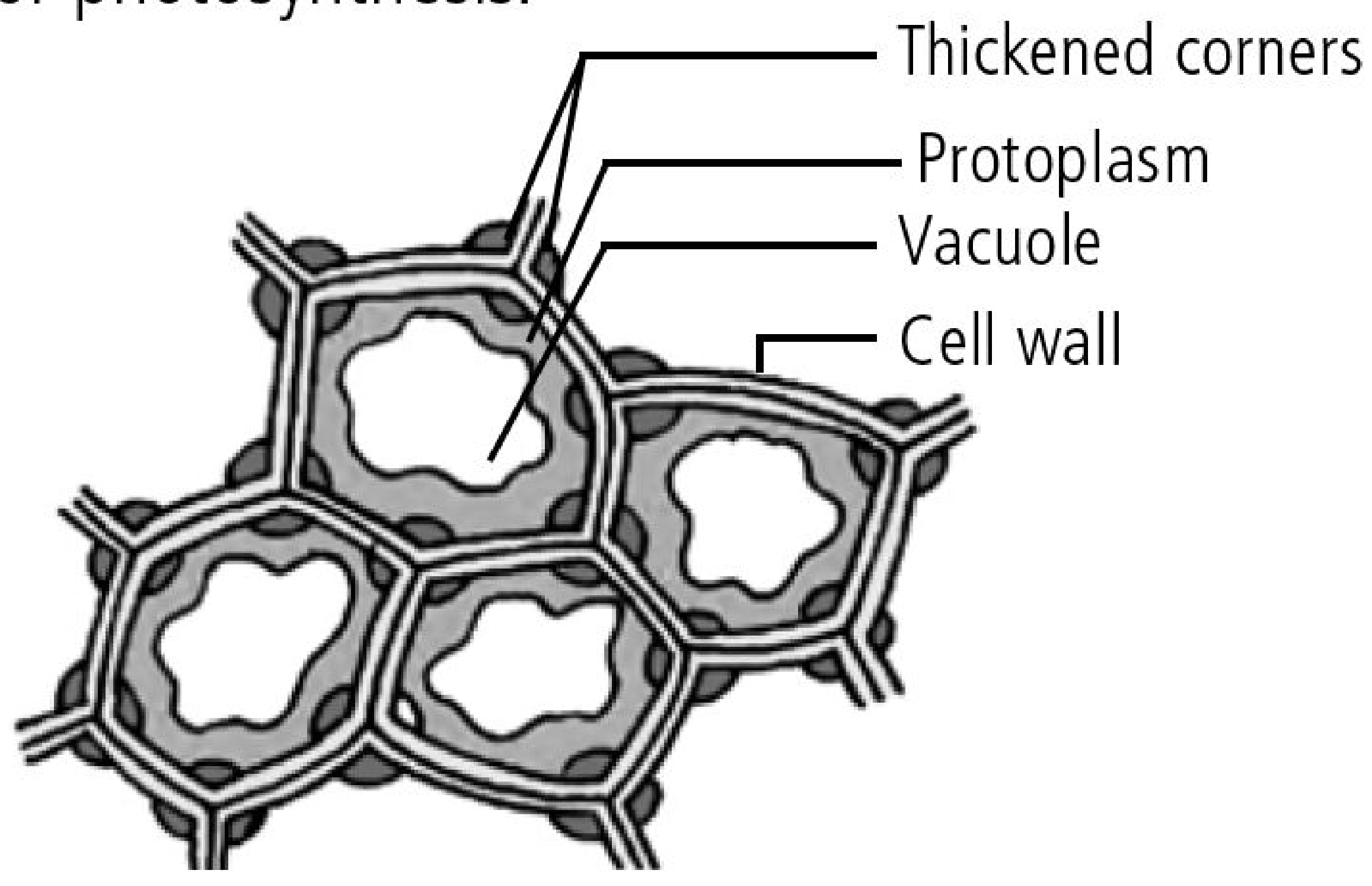


Fig.: Collenchyma

(iii) **Sclerenchyma :** It consists of dead cells with hard and extremely thick secondary walls due to uniform deposition of **lignin.** Sclerenchyma is of two types, sclerenchyma fibres and sclereids. The **sclerenchyma fibres** occur in all those parts where mechanical strength is required. **Sclereids** are found in fruit walls of nuts and seed coat of legumes.

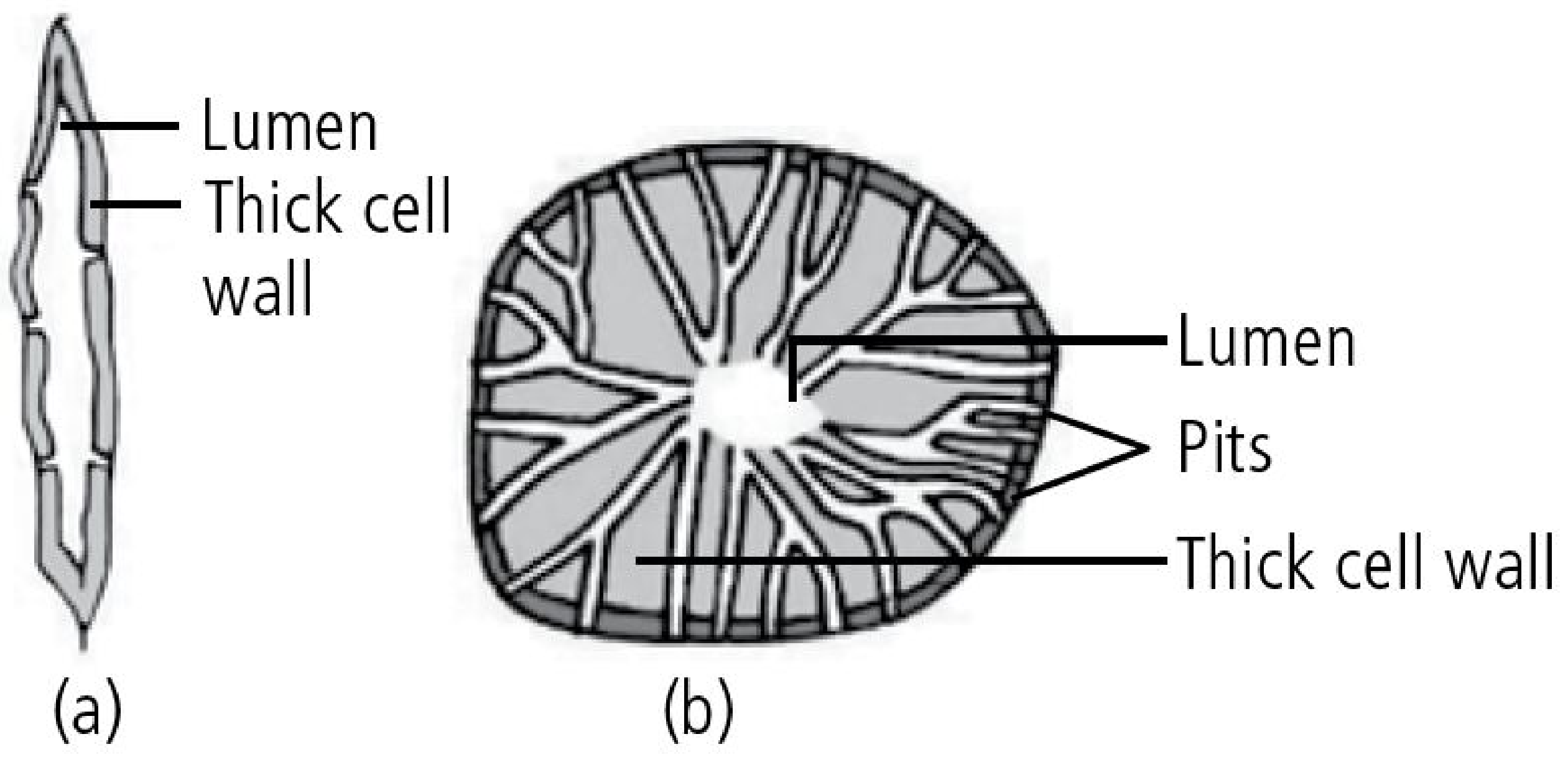


Fig.: Sclerenchyma : (a) A fibre ; (b) A sclereid

- Permanent tissues with more than one type of cells working as a unit are called **complex permanent tissues.** Complex permanent tissues include xylem and phloem.

Xylem

- Xylem functions as a conducting tissue for water and minerals from roots to the stem and leaves. It also provides mechanical strength to the plant parts. Xylem is composed of four different kinds of elements, *viz*., tracheids, vessels, xylem fibres and xylem parenchyma.
  (i) **Xylem tracheids :** Tracheids are elongated or tube-like cells with thick and lignified walls and tapering ends. These are dead and are without protoplasm. They are primitive conducting elements of xylem, present in pteridophytes and gymnosperms. The inner layers of the cell walls have thickenings which vary in form (annular, spiral, reticulate, scalariform or pitted). In flowering plants, tracheids and vessels are the main water transporting elements.

  (ii) **Xylem vessels (Tracheae) :** Vessels are advanced conducting elements of xylem. Vessel is a long cylindrical tube-like structure made up of many cells called vessel members, each with lignified walls and a large central cavity.

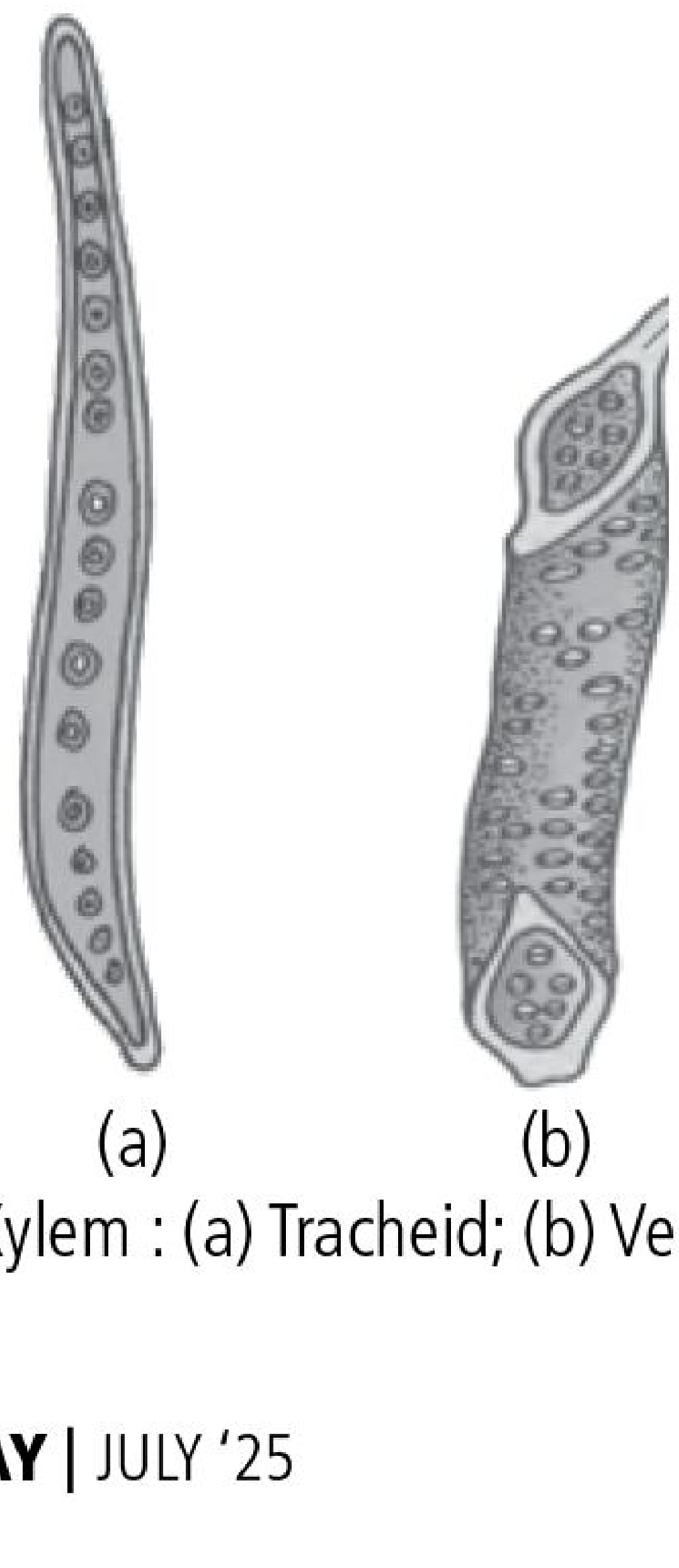


Fig.: Xylem : (a) Tracheid; (b) Vessel

- The vessel cells are also devoid of protoplasm. Vessel members are interconnected through perforations in their common walls. The presence of vessels is a characteristic feature of angiosperms but exceptionally vessels are present in some gymnosperms like *Ephedra*, *Gnetum* and *Welwitschia* (Order Gnetales).
  (iii) **Xylem fibres (wood fibres) :** Sclerenchyma fibres which are present in xylem are called as xylary fibres or xylem fibres or wood fibres. Xylem fibres have highly thickened walls and obliterated central lumens. These may either be septate or aseptate.

  (iv) **Xylem parenchyma :** Xylem parenchyma cells are living and thin-walled and their cell walls are made up of cellulose. They store food materials in the form of starch or fat, and other substances like tannins. The radial conduction of water takes place by the ray parenchymatous cells.
- On the basis of **origin**, xylem is divided into **primary xylem** and **secondary xylem.**
- Primary xylem is of two types – protoxylem and metaxylem. The first formed primary xylem elements are called **protoxylem** and the later formed primary xylem is called **metaxylem.**
- In stems, the protoxylem lies towards the centre (pith) and the metaxylem lies towards the periphery of the organ. This type of primary xylem is called **endarch.** In roots, the protoxylem lies towards periphery and metaxylem lies towards the centre. This type of arrangement of primary xylem is called **exarch.**
- Xylem formed during secondary growth is called secondary xylem. Secondary xylem is not differentiated into protoxylem and metaxylem.

Phloem

- Phloem transports food materials, usually from leaves to other parts of the plant. Phloem in angiosperms is composed of sieve tube elements, companion cells, phloem parenchyma and phloem fibres. Gymnosperms have albuminous cells and sieve cells. They lack sieve tubes and companion cells.
  (i) **Sieve cells or sieve tube elements :** Sieve tube elements are long, tube-like structures, arranged longitudinally and are associated with the companion cells. Sieve tubes are examples of living syncyte (structure which is formed by fusion of cells). Their end walls are perforated in a sieve-like manner to form the sieve plates. A mature sieve element possesses a peripheral cytoplasm and a large vacuole but lacks a nucleus. The functions of sieve tubes are controlled by the nucleus of companion cells.

(ii) **Companion cells :** The companion cells are specialised parenchymatous cells, which are closely associated with sieve tube elements. The sieve tube elements and companion cells are connected by pit fields present between their common longitudinal walls. Sieve tube element and companion cell originate from the same meristematic cell. So they are also called as **sister cells**. The companion cells help in maintaining the pressure gradient in the sieve tubes.

(iii) **Phloem parenchyma :** Phloem parenchyma is made up of elongated, tapering cylindrical cells which have dense cytoplasm and nucleus. The cell wall is composed of cellulose and has pits through which plasmodesmatal connections exist between the cells. The phloem parenchyma stores food material and other substances like resins, latex and mucilage. It is absent in most of the monocotyledons.

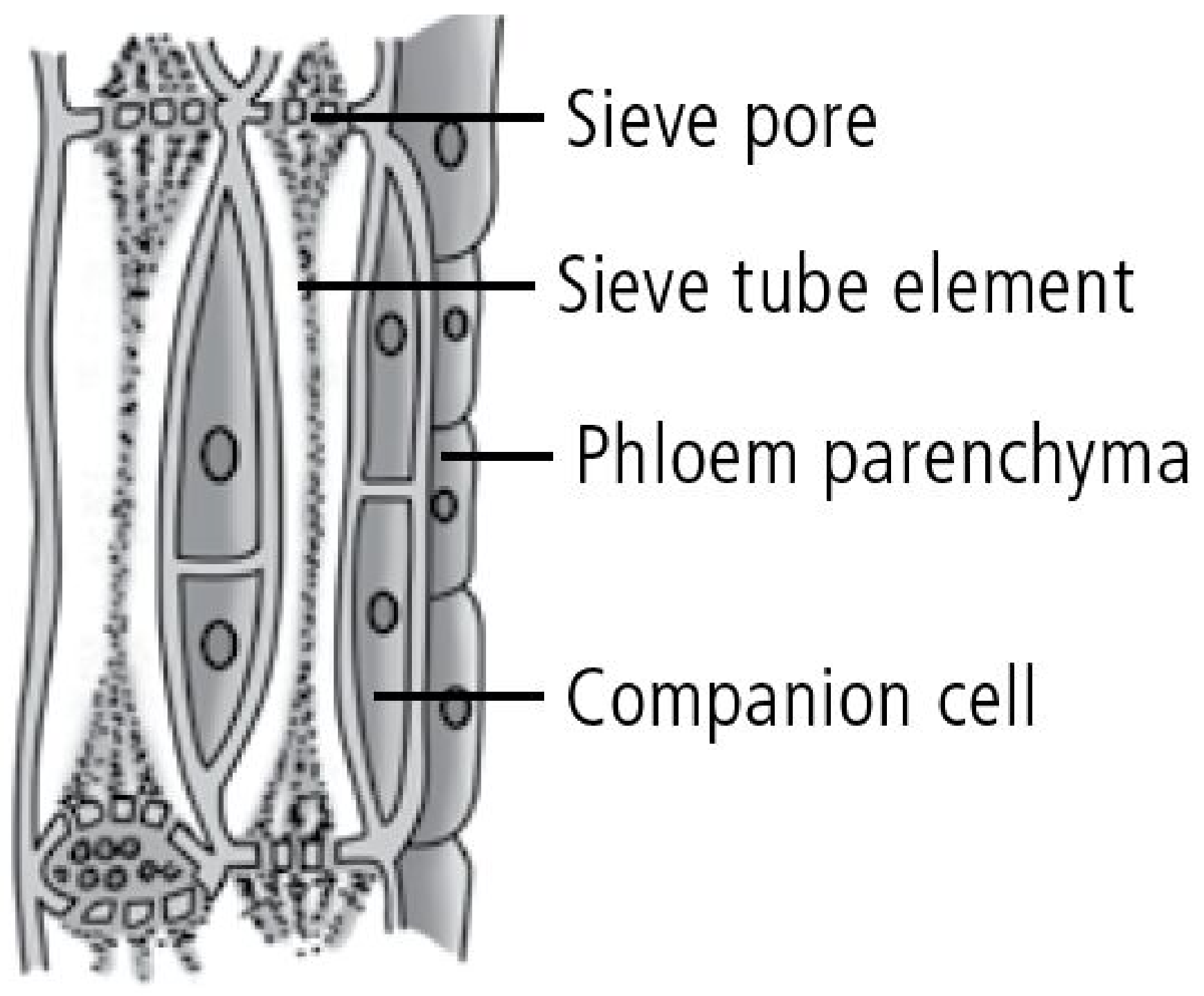


Fig.: Phloem

(iv) **Phloem fibres :** The cell wall of phloem fibres is quite thick. At maturity, these fibres lose their protoplasm and become dead. Phloem fibres are generally absent in the primary phloem but are found in the secondary phloem. These are much elongated, unbranched and have pointed, needle-like apices. Phloem fibres are also called **extra xylary fibres** or **bast fibres**. These are **commercial fibres**. The bast fibres of Jute (*Corchorus capsularis*), Sunn hemp (*Crotolaria juncea*), Hemp (*Cannabis sativa*) and Flax (*Linum usitatissimum*) are used commercially.

- On the basis of **origin**, phloem is divided into **primary phloem** and **secondary phloem**. **Primary phloem** originates from primary meristem during primary growth. It is of two types – protophloem and metaphloem. The first formed primary phloem elements are called **protophloem** (narrow sieve tubes) and the later formed primary phloem is called **metaphloem** (bigger sieve tubes).

WHO AM I ...

"I am a dead cell and found in fruit walls of nuts and seed coat of legumes."

...search me ☺

- **Secretory or special tissues** are concerned with the secretion of various substances like resins, gums, tannins, latex, nectar, etc. There are two types of secretory tissues: glandular and laticiferous tissues.

THE TISSUE SYSTEMS

- Tissues together form tissue system which are of **three types : epidermal tissue system, ground tissue system** and **vascular tissue system.**

Epidermal Tissue System

- Epidermal tissue system consists of **epidermis** and **epidermal outgrowths.** Epidermis is the superficial layer covering the entire surface of the primary plant body and is itself covered with cuticle on aerial parts. All the epidermal cells are living (parenchymatous)**. Epidermal outgrowths** may include **trichomes** (present on stem, prevent water loss), **root hairs** (present on root, absorb water and minerals from soil), etc.
- **Stomata** are the structures present on the epidermis of leaves for regulation of transpiration and gaseous exchange. The specialised green epidermal cells present around the stomata are called **guard cells** which regulate stomatal opening.Guard cells in **dicots** are **kidney** (bean) shaped and in **monocots** are **dumb-bell** shaped. The guard cells are surrounded by two or more epidermal cells called **subsidiary cells.** When subsidiary cells lie above the guard cells, the stomata are called **sunken.**

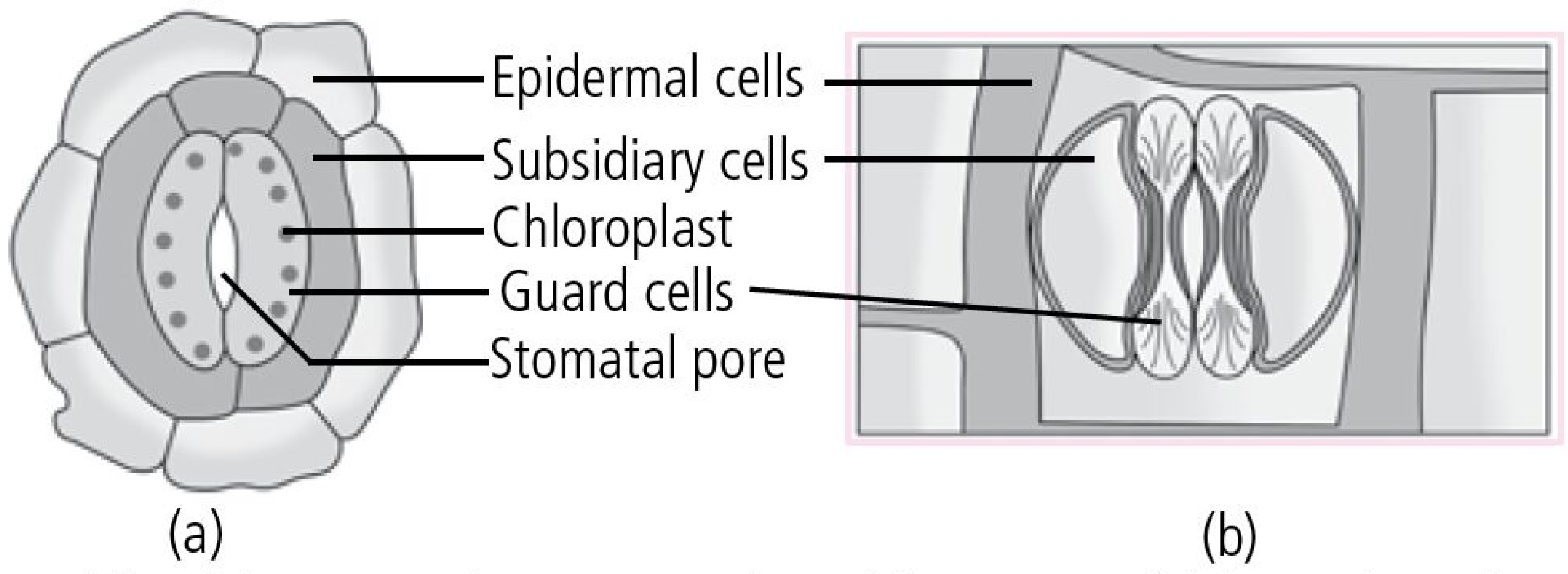


Fig.: Diagrammatic representation : (a) stomata with bean-shaped guard cells; (b) stomata with dumb-bell shaped guard cells

Ground Tissue System

- It consists of simple tissues and is derived partly from **periblem** and partly from **plerome.** It is of two types - **extrastelar (cortex)** and **intrastelar (includes pericycle, pith** and **medullary rays).** In leaves, it consists of chloroplast containing cells and is called **mesophyll.**

Vascular Tissue System

- Vascular tissue includes **stele** *i.e.*, central column of plant body that consists of vascular bundles and pith (if present). It lies inner to pericycle. Each **vascular bundle** comprises of **xylem** and **phloem** and **cambium** (if present).

VASCULAR TISSUE SYSTEM

- The vascular tissue system comprises phloem and xylem. The elements of xylem and phloem are always organised in groups and are called **vascular bundles**. In the open vascular bundles of dicotyledons, a meristematic region, **cambium** is present between the phloem and xylem which is known as the intrafascicular cambium. Contrary to this, in the monocotyledons, the vascular bundles are without cambium and are called closed.

Types of vascular bundles

- According to the mode of occurrence of the vascular elements, following types of vascular bundles are known :
  - Radial vascular bundles
  - Conjoint vascular bundles
  - Concentric vascular bundles

(i) **Radial vascular bundles :** Radial vascular bundles are common in roots. Xylem and phloem are present in the form of separate bundles and the two types are present in an alternate manner. They remain at different radii of an axis and are separated by non-conducting tissues.

(ii) **Conjoint vascular bundles :** Conjoint vascular bundles are not common in roots. Here xylem and phloem are present on the same radius of an axis. Two types of conjoint vascular bundles are collateral and bicollateral vascular bundles.

(a) **Collateral :** In the stems and leaves of angiosperms and gymnosperms, collateral vascular bundles are present. Here, phloem and xylem remain together on the same radius (arranged side by side) with the xylem towards the pith (*i.e.*, internal) and the phloem towards the outer side (*i.e.*, external). The vascular bundles are said to be open when a strip of vascular cambium occurs between the xylem and phloem of each vascular bundle. The vascular bundles are said to be closed when the cambium is absent in each vascular bundle. Closed vascular bundles are found in stems of monocotyledons.

WHO AM I ...

"I am the type of cells found in leaves and are responsible for photosynthesis."

...search me ☺

(b) **Bicollateral :** In bicollateral vascular bundles, phloem patches occur on both sides of the xylem. The phloem present on the outer side of xylem as in collateral vascular bundle is called outer or external phloem. Phloem present on the inner side of xylem is called inner or internal phloem. This type of vascular bundle occurs in the Family Cucurbitaceae. These bundles are always open as the outer and inner patches of phloem are separated from the central xylem by two strips of cambium.

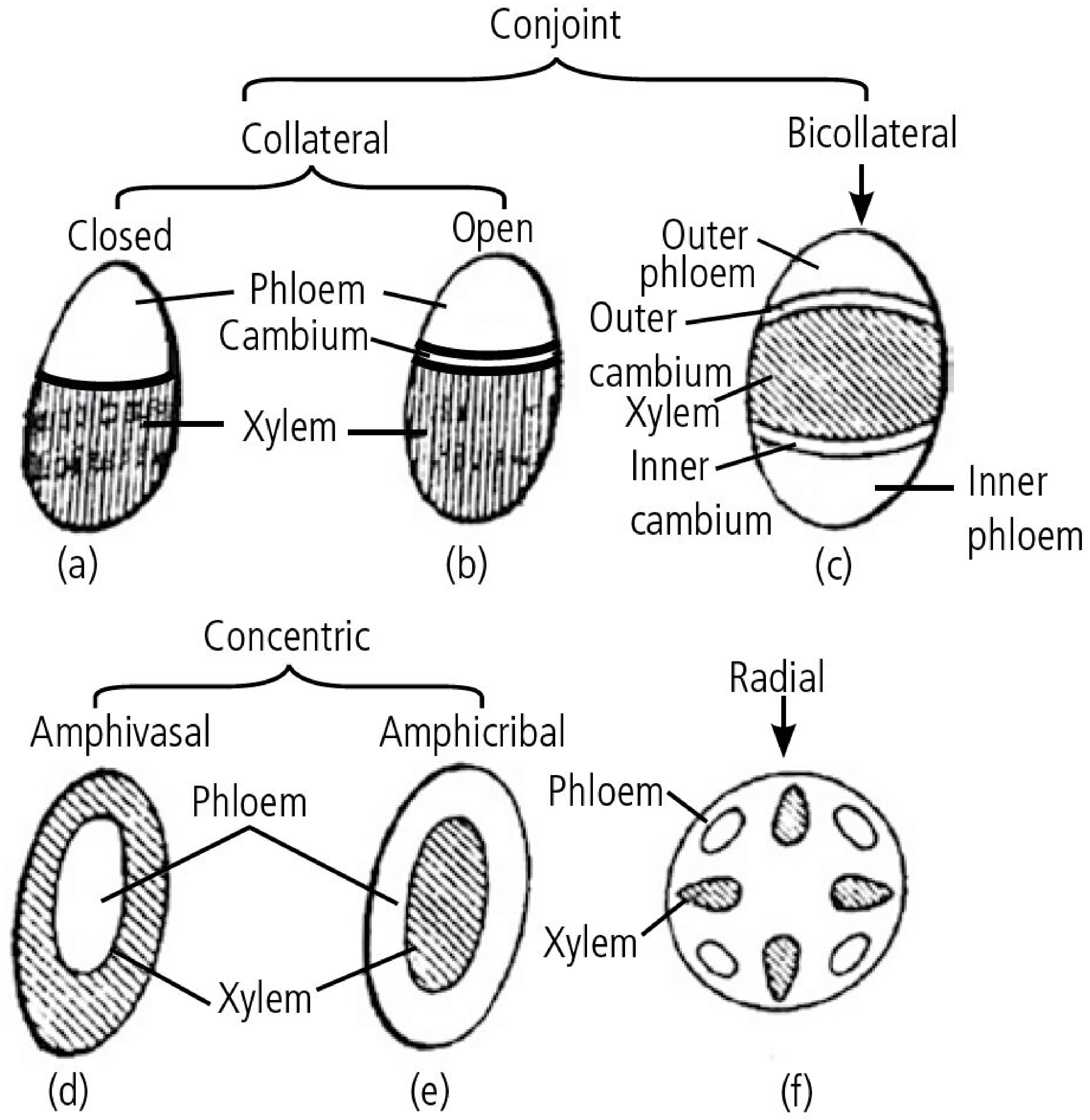


Fig.: Different types of vascular bundles (a-f)

(iii) **Concentric vascular bundles :** In this type of vascular bundle, one type of vascular tissue completely surrounds the other type and the later forms a solid core. There are two types of concentric vascular bundles:

(a) **Amphicribal or Hadrocentric:** Here, phloem surrounds the xylem and xylem forms a central core. These are frequently found in ferns, in some leaves of dicotyledons and in some aquatic angiosperms. They are also called endoxylic or ectophloic.

(b) **Amphivasal or Leptocentric :** In this type of vascular bundle, xylem surrounds the phloem completely and phloem forms a central core. This type is found in some monocotyledons, in *Yucca* and in *Dracaena*. They are also called endophloic or ectoxylic.

INTEXT PRACTICE QUESTIONS

6. Differentiate between exarch and endarch xylem.

7. What are the shapes of stomata in dicots and monocots?

ANATOMY OF DICOT AND MONOCOT PLANTS

- For a better understanding of tissue organisation of roots, stems and leaves, it is convenient to study the transverse sections of the mature zones of these organs. These are summarised in the following tables.

Table : Differences between internal structure of root and stem

	Characters	Root	Stem
1.	Outer layer	Epiblema	Epidermis
2.	Hypodermis	Hypodermis is usually absent in young roots. A thick walled exodermis is present in some cases.	Sclerenchymatous or collenchymatous
3.	Ground tissue	Chloroplasts are almost invariably absent.	A few outer cells of the ground tissues may contain chloroplasts.
4.	Cortex	Cortex is broad	Cortex is narrow
5.	Endodermis	Well developed	Absent or poorly developed
6.	Vascular bundle	Radial	Conjoint, collateral or bicollateral
7.	Xylem	Exarch	Endarch

Table : Differences between monocot root and dicot root

	Characters	Monocot root	Dicot root
1.	Cortex	Cortex is very wide.	Cortex is comparatively narrow.
2.	Endodermis	Casparian strips are visible only in young root. The endodermal cells later become highly thickened.	Endodermis is less thickened and Casparian strips are more prominent.
3.	Vascular bundle	Polyarch *i.e.* more than 6 vascular bundles.	Diarch to hexarch *i.e.* 2 - 6 vascular bundles.
4.	Conjunctive tissue	Parenchymatous or sclerenchymatous	Parenchymatous
5.	Cambium	Absent	Present, so secondary growth occurs
6.	Pith	Well developed large pith	Poorly developed
7.	Activity of pericycle	Gives rise to lateral roots only.	Gives rise to lateral roots, cork cambium and part of the vascular cambium.

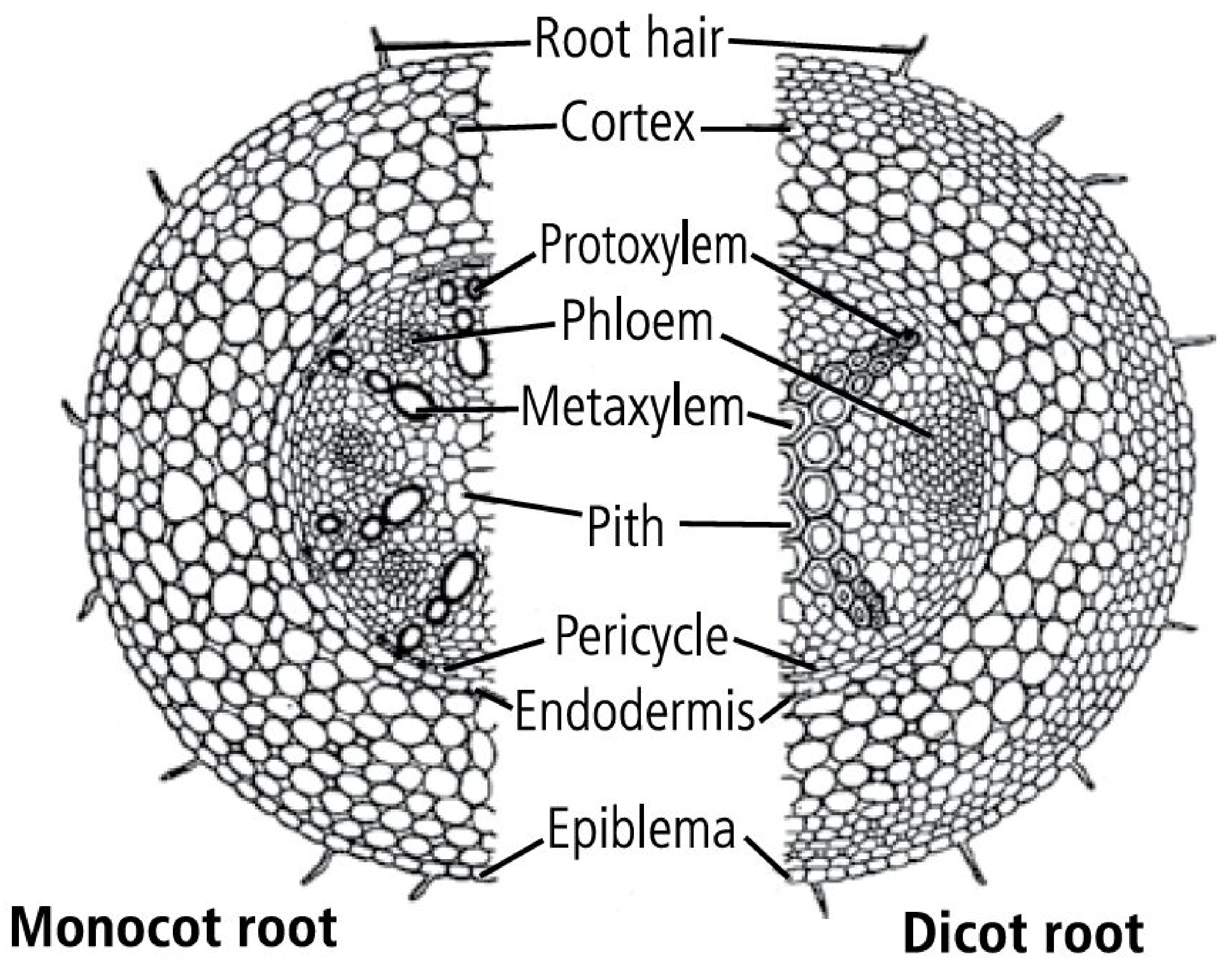

Root hair
Cortex
Protoxylem
Phloem
Metaxylem
Pith
Pericycle
Endodermis
Epiblema
Monocot root
Dicot root

Fig.: Comparison of the T.S. of monocot and dicot roots

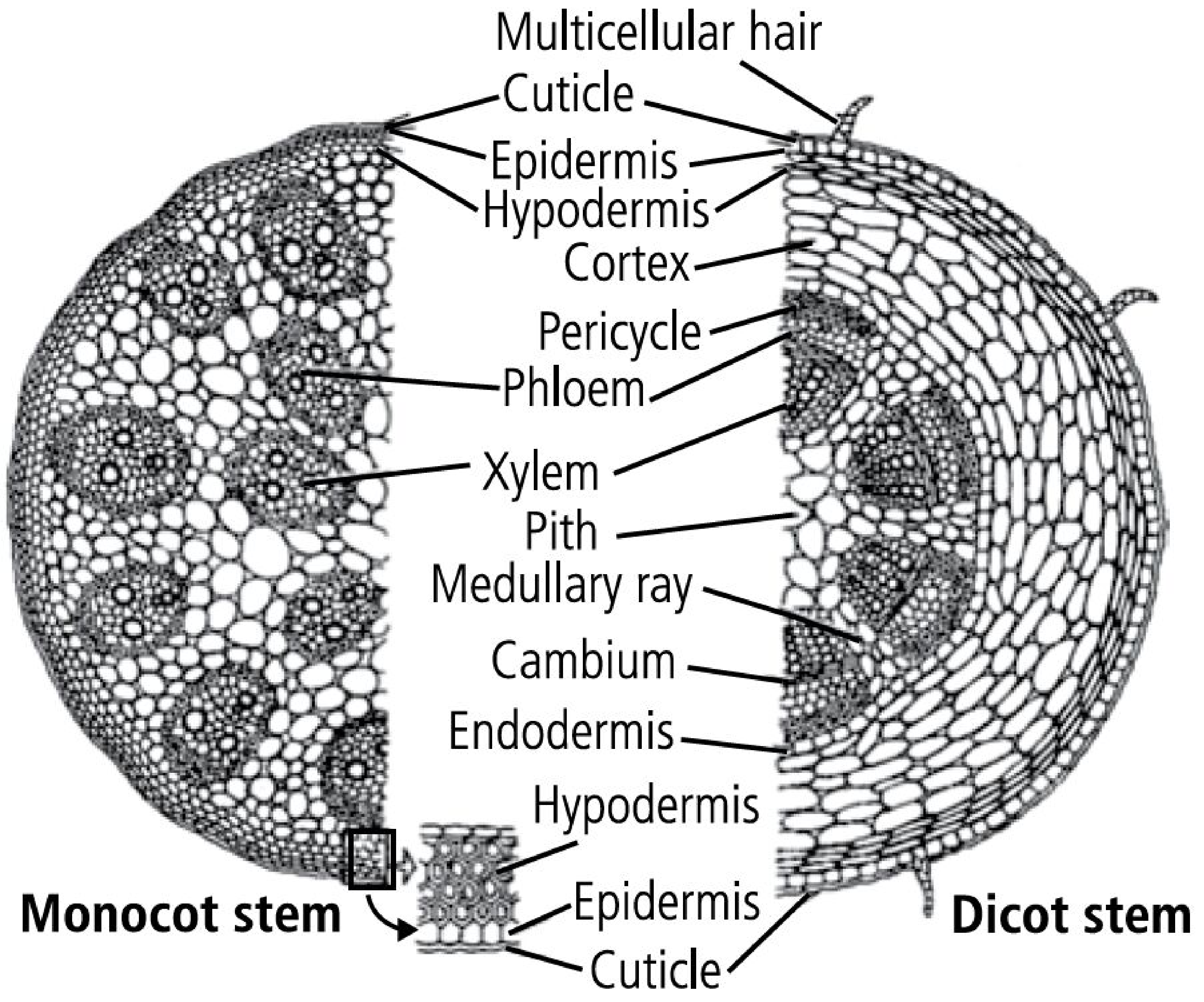

Multicellular hair
Cuticle
Epidermis
Hypodermis
Cortex
Pericycle
Phloem
Xylem
Pith
Medullary ray
Cambium
Endodermis
Hypodermis
Monocot stem
Epidermis
Cuticle
Dicot stem

Fig.: Comparison of the T.S. of monocot and dicot stems

Table : Differences between monocot stem and dicot stem

	Characters	Monocot stem	Dicot stem
1.	Epidermis	Single layered, without epidermal hair.	Single layered with multicellular hair and trichomes.
2.	Hypodermis	Sclerenchymatous	Collenchymatous
3.	Ground tissue	Not differentiated.	Differentiated into cortex, endodermis, pericycle, pith etc.
4.	Endodermis	Absent	Present with starch grains, Casparian strips are generally absent.
5.	Pericycle	Absent	Few layered thick.
6.	Medullary rays	Absent	Parenchymatous, found in between vascular bundles
7.	Pith	Absent	Centrally placed with parenchymatous or occasionally sclerenchymatous cells.
8.	Vascular bundles	(a) Scattered (b) Conjoint, collateral, closed. (c) Sclerenchymatous bundle sheath usually present.	(a) Vascular bundles in a ring. (b) Conjoint, collateral or bicollateral and open. (c) Bundle sheath absent.
9.	Phloem parenchyma	Absent	Present
10.	Xylem vessel	Y or V shaped due to disintegration of protoxylem. Lysigenous water cavity is formed.	Polygonal in outline
11.	Secondary growth	Usually absent	Usually present

Table : Differences between monocot leaf and dicot leaf

	Characters	Monocot leaf	Dicot leaf
1.	Symmetry	Isobilateral	Dorsiventral
2.	Stomata distribution	Amphistomatic *i.e.*, stomata equally distributed on both the surfaces.	Hypostomatic *i.e*, stomata present largely on lower surface of leaf.
3.	Bulliform cells	Present on upper epidermis.	Usually absent
4.	Mesophyll	Mesophyll is undifferentiated. Only spongy parenchyma is present which has very small intercellular spaces.	Made up of two types of tissues : (a) Palisade parenchyma (b) Spongy parenchyma with large intercellular spaces.
5.	Bundle sheath	Made of parenchyma. Bundle sheath extensions are sclerenchymatous.	Made up of parenchyma. Bundle sheath extensions are parenchymatous.

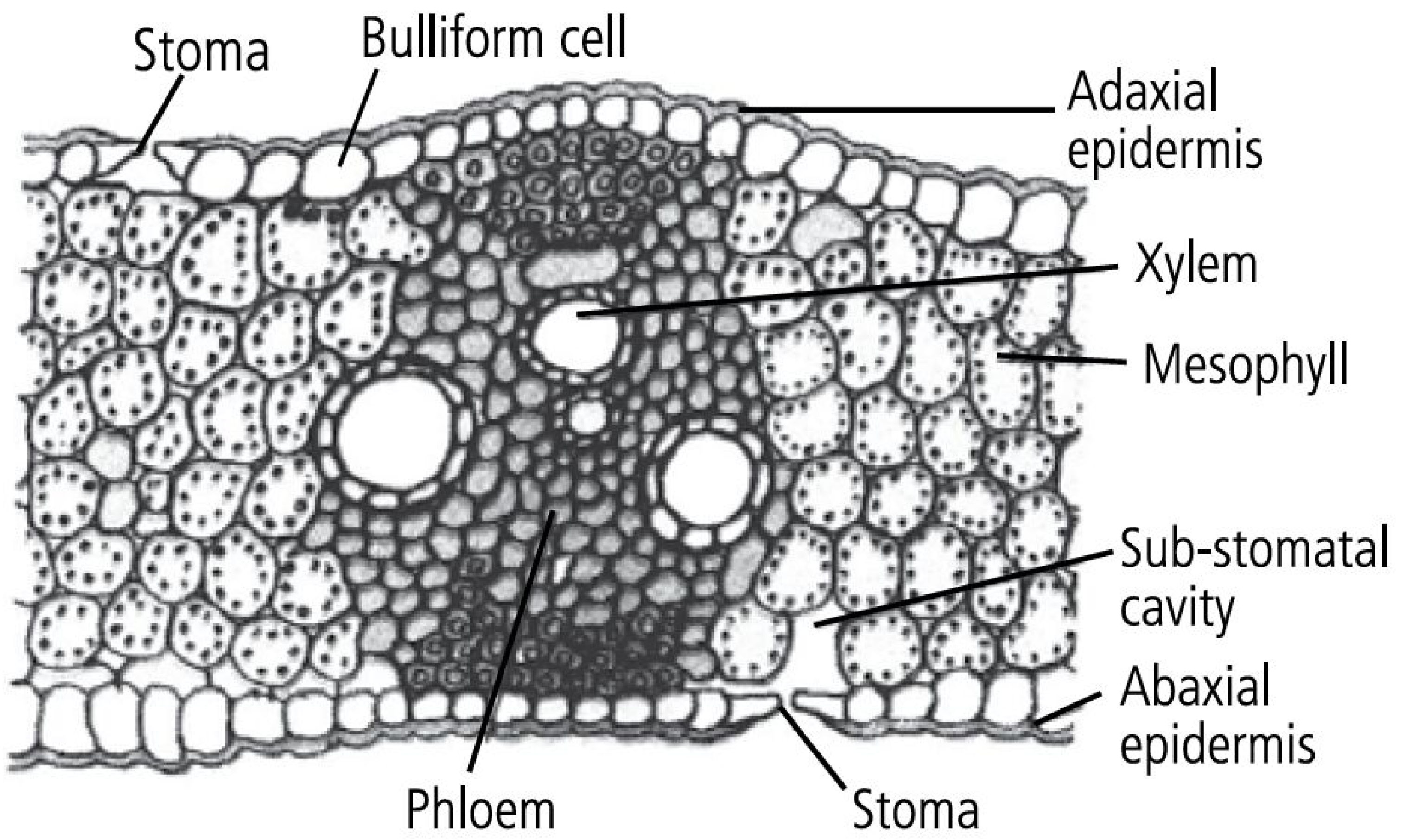

Stoma
Bulliform cell
Adaxial epidermis
Xylem
Mesophyll
Sub-stomatal cavity
Abaxial epidermis
Phloem
Stoma

Fig.: T.S. of monocot leaf

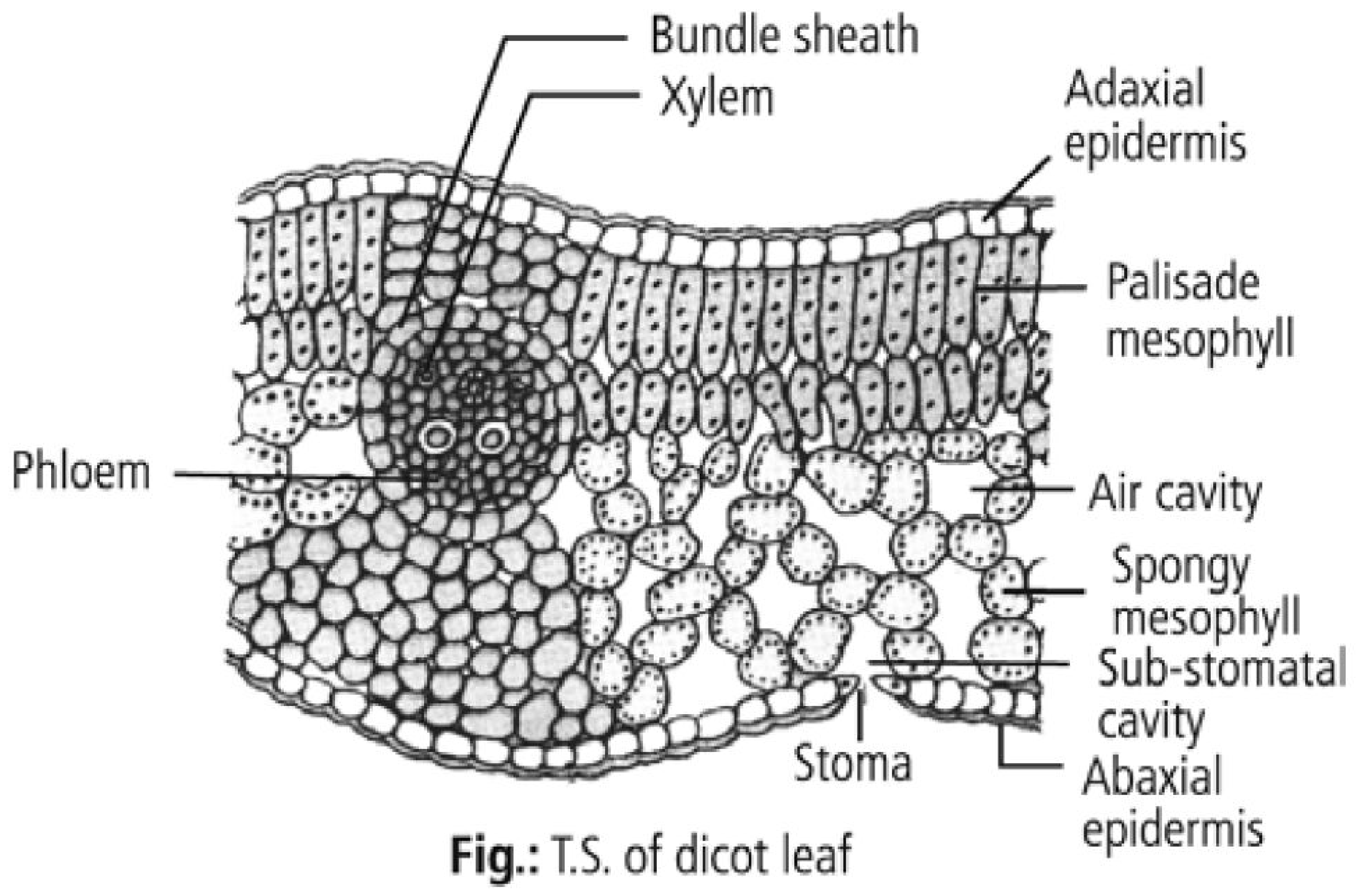

Bundle sheath
Xylem
Adaxial epidermis
Palisade mesophyll
Phloem
Air cavity
Spongy mesophyll
Sub-stomatal cavity
Stoma
Abaxial epidermis

Fig.: T.S. of dicot leaf

SECONDARY GROWTH

- In dicots of angiosperms and gymnosperms, the primary body forms the fundamental structure and increase in girth and diameter takes place by the formation of secondary tissue. This formation of secondary tissue is called secondary growth.
- Secondary growth is the growth in thickness due to the formation of secondary tissues by lateral meristems. With the exception of some annuals, most of the dicots and gymnosperms show secondary growth in their roots.
- It takes place by the production of two types of secondary tissues: secondary vascular tissues and periderm. These tissues are formed by meristems, vascular cambium and cork cambium respectively.
- Secondary growth results in the formation of a large amount of secondary xylem called wood and an external layer known as bark.

Secondary growth in dicot roots

- Secondary growth in dicotyledonous roots occurs by the initiation and activity of two secondary meristems– (i) vascular cambium and (ii) cork cambium (or phellogen).

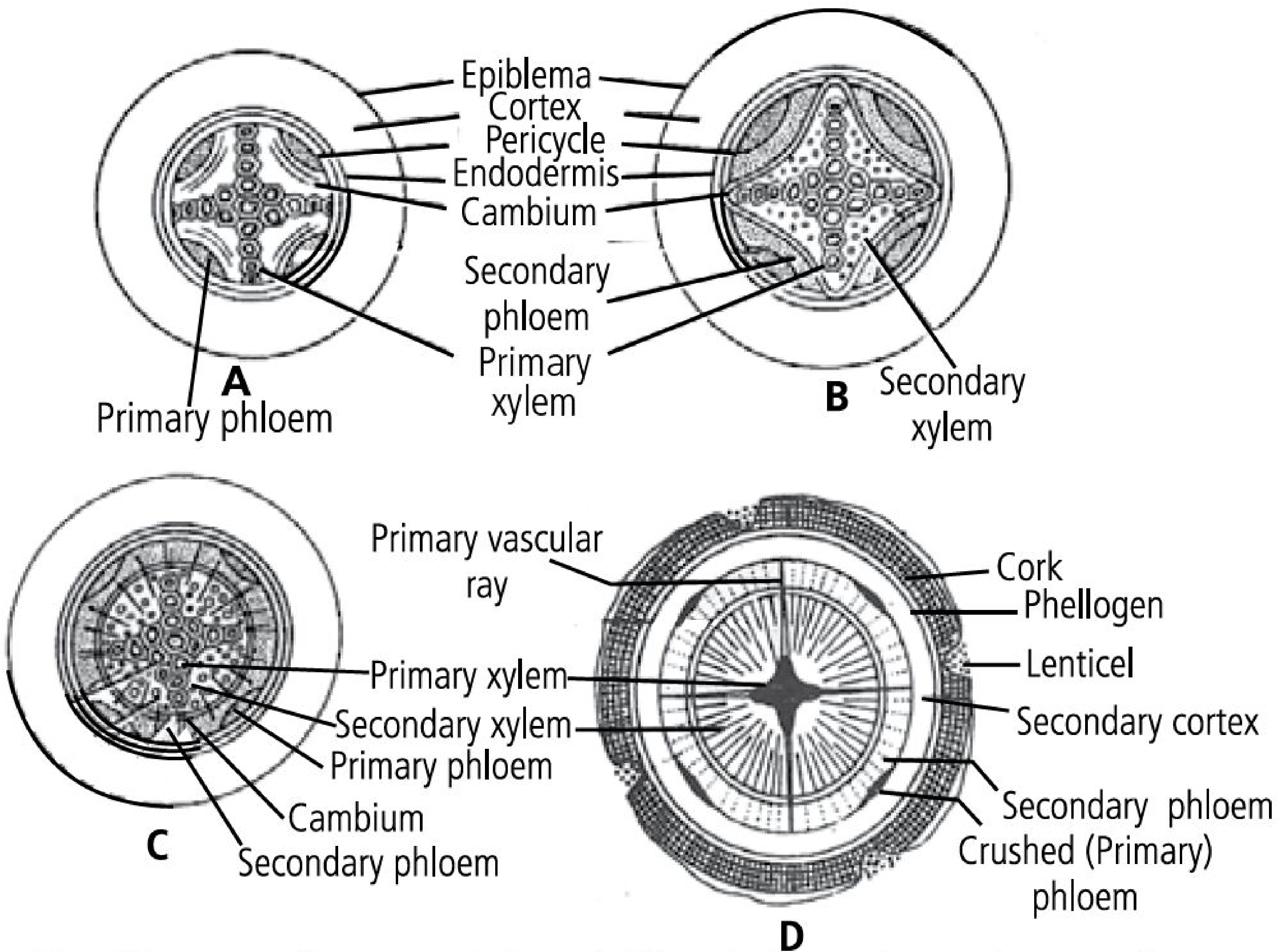


Fig.: Diagrammatic representation of different stages of secondary growth in dicot roots

Stelar growth by vascular cambium

- The process of stelar secondary growth in dicotyledonous roots begins with the initiation of vascular cambium strips which develop from the parenchymatous cells present along the inner edges of primary phloem. The number of cambial strips depends on the number of phloem or xylem strands.
- The cells of cambium strips (vascular cambium) divide repeatedly to produce new cells both towards inner as well as outer side. The cells produced towards inner side (centripetally) differentiate into secondary xylem elements and those produced towards outer side (centrifugally) differentiate into secondary phloem.
- Subsequently, the cells of pericycle lying towards outer side of protoxylem divide by tangential division.
- The inner derivatives of these cells become meristematic and function as cambium. These join with cambia derived from phloem strands to form a complete ring of cambium. Thus, a continuous wavy ring is produced which is present below the phloem but above the xylem and is secondary in origin. Soon, the cambium becomes circular by its divisions and secondary tissue formation.
- Some cambial cells may function as ray initials and produce secondary medullary rays. Secondary vascular tissue assumes the shape of continuous cylinder interrupted at places where wide vascular rays connect primary xylem to cortex through pericycle and endodermis.
- The primary xylem remains in its original position but the primary phloem is pushed towards outer side and crushed.

Extrastelar growth by cork cambium

- Addition of more and more tissues of secondary xylem and secondary phloem in the central part of root exerts pressure towards periphery. The tissues outside this zone of active growth get crushed and are sloughed off. To avoid injury to secondary phloem, the roots develop a new cambium ring in the pericycle, called cork cambium (phellogen).
- The cells of **cork cambium (phellogen)** divide to form cells of **cork (phellem) towards outer side** and **secondary cortex (phelloderm) towards inner side**. It results in the formation of outer protective covering consisting of multilayered cork, cork cambium and multilayered secondary cortex. These three layers collectively constitute the **periderm.**

Secondary growth in dicot stems

- The dicotyledonous stems are characterised by presence of fascicular (intrafascicular) cambium (primary meristem) derived from procambium of shoot apical meristem between xylem and phloem.
- Interfascicular cambium (secondary meristem) arises from the cells of medullary rays which occur at the level of intrafascicular strips.
- The cambium ring formed by joining of fascicular and interfascicular cambium, is called vascular cambium. It is composed of two types of cells– the **fusiform initials** and the **ray initials**.
- The cells of cambium mostly divide by periclinal divisions. Out of the two cells produced from single cell of cambium, one differentiates into secondary tissue and the other remains cambial cell. In this way the cambial cells, by repeated divisions, add new cells either towards centre or towards periphery and the cambium still remains single layered.

Formation of secondary xylem and secondary phloem

- The fusiform initials of cambium ring divide by tangential divisions and add new cells. The new cells produced toward inner side (*i.e.*, towards primary xylem) may remain meristematic for sometime and differentiate into elements of secondary xylem. On the other hand, the new cells produced towards outer side (*i.e.*, towards primary phloem) remain meristematic for a limited period and differentiate into secondary phloem. The primary phloem gets crushed.

Formation of secondary medullary rays

- Ray initials of cambium ring divide by tangential divisions and add new cells which form secondary medullary rays. They are usually one to few layers in thickness and one to several layers in height. The medullary rays form the radial system responsible for radial conduction of solutes. They maintain connection between pith and cortex.

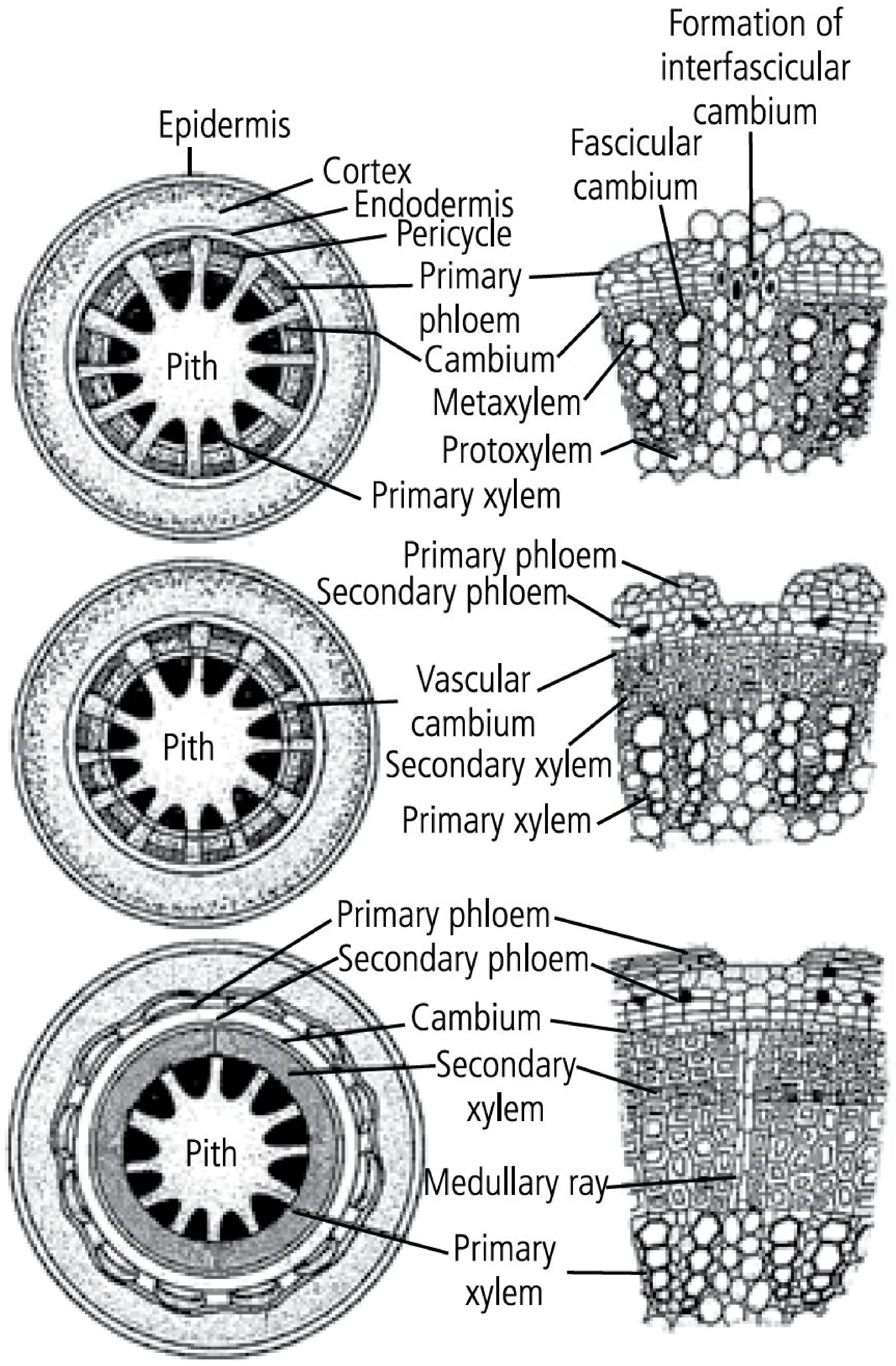


Fig.: Diagrammatic representation of various stages of secondary growth in dicot stem

Formation of periderm

- In order to provide an increase in girth and prevent harm to outer ground tissues, dicot stems produce a cork cambium (or phellogen) in the outer cortical cells. Phellogen cuts derivatives on the outer side to form cork (or phellem) and on the inner side to form secondary cortex or phelloderm. Cork, phellogen and phelloderm are collectively referred to as periderm.
- At places, phellogen produces aerating pores instead of cork. These pores are called **lenticels**. Each lenticel is a mass of loosely arranged suberised cells called **complementary cells.**
- Bark is a non-technical term that refers to all the tissues outside the vascular cambium *viz*. secondary phloem and periderm, in a woody stem in which secondary growth has taken place. Bark formed in early growing season is early or soft bark whereas bark formed towards end of growing season is late or hard bark.

Annual rings

Annual ring (growth ring) is the wood formed in a single year. It consists of two types of wood, spring wood and autumn wood. The spring or early wood is much wider than the autumn or late wood. It is lighter in colour and of lower density. Spring wood consists of larger and wider xylem elements. The autumn or late wood is dark coloured and of higher density. The transition from spring to autumn wood in an annual ring is gradual but the transition from autumn wood to the spring wood of the next year is sudden. Therefore, each year's growth is quite distinct. The number of annual rings corresponds to the age of the plant, the annual rings also give some clue about the climatic conditions of the past through which the plant has passed. Dendrochronology is the science of determining age of trees by counting and analysing annual growth rings of trees.

Sapwood and heartwood

- The wood of the older stems (*Dalbergia*, *Acacia*) formed by secondary growth gets differentiated into two zones, the outer light coloured and functional sapwood or alburnum and the inner darker and non-functional heartwood or duramen.

Table : **Differences between sapwood or alburnum and heartwood or duramen**

	Sapwood (Alburnum)	Heartwood (Duramen)
(i)	It is outer wood of an old stem.	It is the central wood of an old stem.
(ii)	It is light coloured.	It is dark coloured.
(iii)	Living cells are present.	Living cells are absent.
(iv)	Sapwood is the functional part of the secondary xylem or wood.	Heartwood is the non-functional part of secondary xylem or wood.
(v)	The tracheary elements are not plugged by tyloses.	The tracheary elements are plugged by tyloseS.

(vi)	Tracheary elements do not possess any deposition in their lumen.	Tracheary elements have deposition of tannins, resins, gums, etc.
(vii)	Sapwood is lighter.	Heartwood is heavier.
(viii)	It is less durable because it is susceptible to attack by pathogens and insects.	It is more durable due to its little susceptibility to the attack of pathogens and insects.

Anomalous secondary growth

The term anomalous secondary growth is used to indicate the forms of cambial activity that deviate from that commonly found in conifers and in woody dicotyledons of the temperate regions. It occurs in some arborescent monocots (*e.g.*, *Dracaena*, *Yucca*, *Agave*) and storage roots (*e.g.*, beet, sweet potato). In arborescent monocot stems, a secondary cambium grows in hypodermal region. The latter forms conjunctive tissue and patches of meristematic cells. The meristematic patches grow into secondary vascular bundles. Anomalous vascular bundles also occur in cortex (cortical bundles, *e.g.*, *Nyctanthes*) and pith (*e.g.*, *Boerhaavia*). In storage roots (*e.g.*, beet), accessory cambial rings appear in the outside of endodermis. They produce less secondary xylem but more secondary phloem. The secondary phloem contains abundant storage parenchyma.

INTEXT PRACTICE QUESTIONS

8. What is the fate of primary phloem after secondary growth has occurred in a dicot stem?

9. How does periderm formation take place in a dicot stem?

10. What is the significance of periderm to a woody dicotyledonous plant?

☺☺

UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I		Column II
1. SIPOTCERTH	(a)	Association of sea anemone and clown fish.
2. CTNIRNSATPRIO	(b)	It influences the weight of an individual.
3. TIPELUSEPOA	(c)	They are non-amino group and make covalent bond with apoenzyme.
4. DOMCEATNIREAH	(d)	It is a process in which RNA polymerase gets attached to promoter.
5. ECLMSOMAINSM	(e)	It undergoes change in shape, resulting in qualitative anaemia.
6. GTARETRPSOSE	(f)	It is an arrangement in which stamen are attached to corolla of flower.
7. YNRITDOREINTHOEOI	(g)	The adult are radially symmetrical but larvae are bilaterally symmetrical.
8. RYTSHECTOYRE	(h)	IUDs that cannot be classified as non-medicated or Cu^{++} releasing.
9. PBNDZSAZOENEIEI	(i)	Multicellular, asexual buds located on thallus of liverwort.
10. HRMIATCAAN	(j)	They are used to treat abnormal serotonin levels in the mind.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month. Winners' names and answers will be published in next issue.

Class XI

Monthly test drive

This specially designed column enables students to self analyse their extent of understanding of specific chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Series IV Structural Organisation in Animals

Total Marks : 160 **Time :** 40 Min.

1. Non-elastic but flexible tissue which serves to attach the muscles with the bone is
   (a) ligament (b) adipose
   (c) lymph (d) tendon.

2. Smooth muscle fibres are
   (a) cylindrical, unbranched, striated, multinucleate and voluntary
   (b) spindle-shaped, unbranched, non-striated, uninucleate and involuntary
   (c) cylindrical, unbranched, non-striated, multinucleate and involuntary
   (d) spindle-shaped, unbranched, striated, uninucleate and voluntary.

3. Match the given columns and select the correct option.

	Tissue		**Shape**		**Location**
A.	Squamous epithelium	(i)	Elongated	P.	Stomach, intestine
B.	Cuboidal epithelium	(ii)	Irregular	Q.	Alveoli, blood vessels
C.	Columnar epithelium	(iii)	Cube-like	R.	Nephron, salivary ducts

   (a) A-(i)-P, B-(ii)-Q, C-(iii)-R
   (b) A-(ii)-Q, B-(iii)-R, C-(i)-P
   (c) A-(i)-Q, B-(ii)-R, C-(iii)-P
   (d) A-(ii)-R, B-(iii)-P, C-(i)-Q

4. **Assertion (A) :** Smooth muscle fibres do not appear to be striated.
   Reason (R) : Functions of smooth muscle can be directly controlled.
   (a) Both assertion and reason are true and reason is the correct explanation of assertion.
   (b) Both assertion and reason are true but reason is not the correct explanation of assertion.
   (c) Assertion is true but reason is false.
   (d) Assertion is false but reason is true.

5. Frog is basically carnivorous and captures food by
   (a) trilobed tongue
   (b) fast motile forelimb
   (c) unilobed tongue
   (d) bilobed tongue.

6. Match the following columns with reference to frog.

	Column I		**Column II**
A.	Touch	1.	Nasal epithelium
B.	Smell	2.	Foramen magnum
C.	Cranial nerves	3.	Sensory papillae
D.	Medulla oblongata	4.	Peripheral nervous system

	A	**B**	**C**	**D**
(a)	3	1	2	4
(b)	2	1	4	3
(c)	3	4	2	1
(d)	3	1	4	2

7. Fallopian tube is lined by which epithelium?
   (a) Ciliated
   (b) Pseudostratified
   (c) Cuboidal
   (d) Columnar

8. Male frog can be distinguished from female frog by the presence of
   (a) vocal sacs and copulatory pad on the first digit of the forelimb
   (b) a neck and trunk
   (c) the hindlimb that ends in five digits
   (d) eyes which are bulged.

9. Condition of the obesity is due to
(a) excess of blood
(b) more thickened bones
(c) more areolar tissues
(d) more adipose tissues.

10. Cardiac muscles are
(a) striated, branched and voluntary
(b) unstriated, unbranched and involuntary
(c) smooth, spindle-shaped and involuntary
(d) striated, cross-connected and involuntary.

11. In frog, a thin-walled urinary bladder is present _______ to the rectum and opens in the _______.
(a) ventral, cloaca
(b) dorsal, ureter
(c) ventral, urethra
(d) dorsal, cloaca

12. Hindbrain of a frog consists of
(a) cerebellum and medulla oblongata
(b) olfactory lobes and cerebral hemispheres
(c) a pair of optic lobes
(d) cerebrum and cranium.

13. Muscular tissue is differentiated into
(a) skeletal and cardiac only
(b) skeletal, smooth and cardiac
(c) cardiac and unstriped only
(d) striped and unstriped only

14. Read the following statements and select the correct option.
Statement I : If the head of a cockroach is cut off, it will remain alive for as long as one week.
Statement II : The head of cockroach holds a bit of nervous system.
(a) Both statement I and statement II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

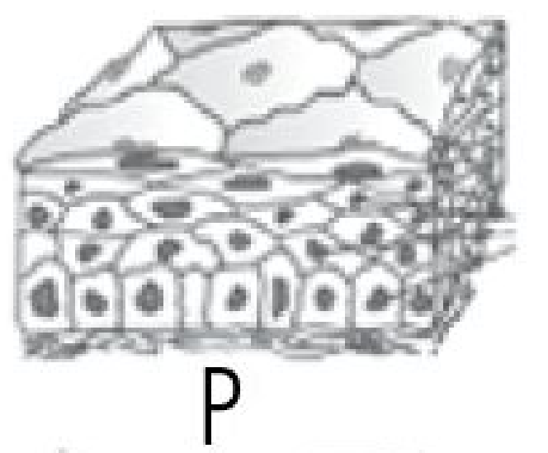
15. How many among the given do not belong to special connective tissues?

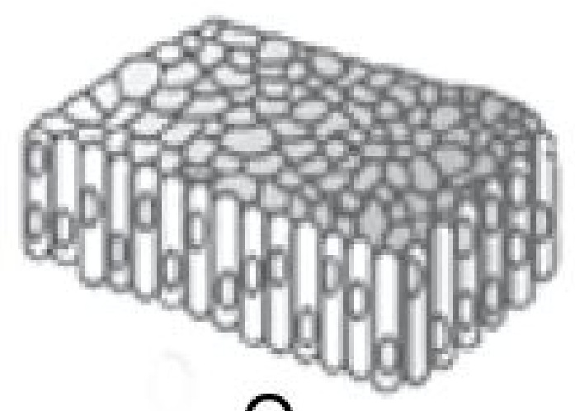
Tendons, Cartilage, Bone, Ligaments, Blood, Adipose tissue, Areolar tissue

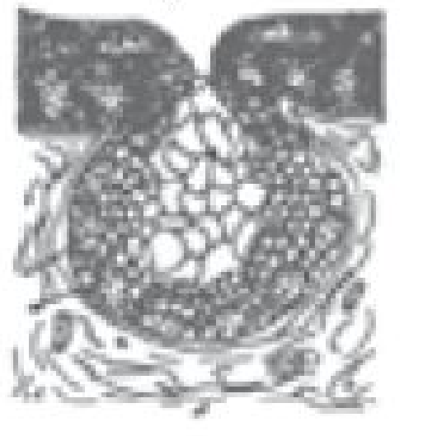
(a) 4 (b) 2
(c) 3 (d) 6

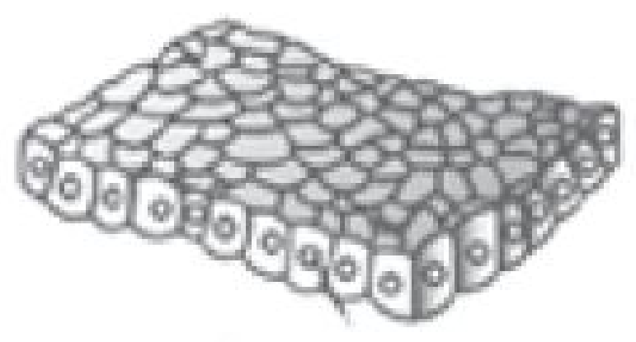
16. The circulatory system of frog is
(a) open type
(b) closed type
(c) double-circulatory
(d) portal.

17. In the following figures of different epithelial tissue, one is related with protection. It is


P


Q


R


S

(a) P (b) Q
(c) R (d) S

18. The respiration by lungs in frog is called
(a) pulmonary respiration
(b) pericardial respiration
(c) alveolar respiration
(d) none of these.

19. Consider the following statements about the connective tissue.
I. Their special function is linking and supporting the other organs or tissues of the body.
II. It is the most abundant type of animal tissue.
III. Blood is a specialised connective tissue which contains collagen.
IV. The cells of connective tissue secretes mucous.
Which of the statements given above are incorrect?
(a) I and II (b) II and III
(c) III and IV (d) I, II, III and IV

20. The chondrocyte of connective tissues are
(a) fibre secreting cells (b) bone forming cells
(c) cartilage cells (d) bone destructing cells.

21. Select the correct option for frogs.
(a) The blood vascular system involves blood and blood vessels only.

TRIO

ANSWERS JUNE 2025

The three letter sequence is **B I L**.

B I L O B E D

S T R O **B I L** I

I S O **B I L** A T E R A L

B I L E

Winner : Aabanti Basu, West Bengal

(b) Ureter opens in urinary bladder in males but oviduct open in cloaca in female frog.
(c) The ureter and oviducts open together in cloaca in both male and female frog.
(d) In female frog, ureter and oviduct open separately in cloaca.

22. Read the given statements and select the correct option.
Statement I : Neurons are the main structural and functional unit of neural system.
Statement II : Neural tissue exerts the greatest control over the body's responsiveness to changing conditions.
(a) Both statement I and statement II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

23. Consider the following statements about the hindwings of cockroach.
I. These are broad and thin.
II. They are not used in flying.
III. They are also known as metathoracic wings.
IV. They are opaque dark and delicate.
Which of the statements given above is/are incorrect?
(a) Only I (b) II and IV
(c) I and IV (d) I, II, III and IV

24. Read the following statements and select the correct option.
(i) Blood cells secrete fibres of structural proteins called collagen and elastin.
(ii) Neuroglial cells protect and support the nephrons.
(iii) Osteocytes are present in spaces called lacunae.
(iv) Striated muscle fibres are bundled together in a parallel fashion.
(v) Biceps are involuntary and striated.
(a) Statements (iii) and (iv) are incorrect.
(b) Statements (ii) and (iv) are incorrect.
(c) Statements (i) and (iii) are incorrect.
(d) Statements (i), (ii) and (v) are incorrect.

25. **Assertion (A) :** Bone is a fluid connective tissue.
Reason (R) : Lacunae are small spaces in the lamellae that provide an area for osteocytes.
(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

26. Choose the correct option that together constitutes the genital pouch of female cockroach.
(a) Gonapophyses and vestibulum
(b) Vestibulum and caudal style
(c) Genital chamber and caudal style
(d) Genital chamber and vestibulum

27. Frogs can live in both land and water. They can survive in water as they can respire there easily. Which of the following is responsible for respiration of frog in water?
(a) Skin only
(b) Skin and buccopharyngeal cavity
(c) Skin and lungs
(d) Skin, buccopharyngeal cavity and lungs.

28. The number of pairs of cranial nerves that arises from the brain of frog is ________.
(a) 10 (b) 1
(c) 12 (d) 5

29. Which of the following statements is/are correct in relation with epithelial tissue?
I. It helps in protection.
II. It helps in formation of diffusion boundary.
III. It helps in absorption and secretion.
IV. It helps in locomotion.
(a) Only IV (b) Only II
(c) All except IV (d) All except III

30. In male frog, two ureters act as
(a) urinogenital ducts
(b) genital ducts
(c) urinary bladder
(d) nephridiopores.

31. Select the correct statement from the following regarding frog.
(a) A frog can change skin colour but has constant body temperature
(b) A frog cannot change skin colour but changes body temperature with environment temperature
(c) A frog can change skin colour and body temperature also changes according to environment
(d) A frog cannot change skin colour and have constant body temperature.

32. Match the following columns.

	Column A		**Column B**
(A)	Unicellular gland	1.	Tight junctions
(B)	Facilitation of rapid transfer of ions	2.	Gap junctions
(C)	Stopping of leakage of substance	3.	Salivary glands
(D)	Multicellular glands	4.	Goblet cells of alimentary canal

(a) A-2, B-4, C-3, D-1 (b) A-3, B-4, C-2, D-1
(c) A-4, B-2, C-3, D-1 (d) A-4, B-2, C-1, D-3

33. Read the following statements about cockroach.

(i) In male cockroach, a characteristic mushroom shaped gland is present in the 6th–7th abdominal segments which functions as an accessory reproductive gland.
(ii) Cockroach is uricotelic.
(iii) The fat body and urecose glands are glandular in function.
(iv) Blood from sinuses enter heart through ostia and is pumped anteriorly to sinuses again.

Which of the above statements are correct?

(a) (i), (ii) and (iv)
(b) (ii) and (iii)
(c) (i) and (iv)
(d) (ii) and (iv)

34. Which statement is not correct regarding bones?

(a) Bone matrix is rich in calcium salts.
(b) Lacunae surrounds chondrocytes.
(c) Bone marrow is the site of production of blood cell.
(d) Collagen fibres give strength to bone.

35. Consider the following statements (i)-(iii) and select the correct option stating which ones are true (T) and which ones are false (F).

(i) Connective tissue link and support other tissues.
(ii) Fibroblasts store fat in adipose tissue.
(iii) Salivary glands are multicellular glands.

	(i)	**(ii)**	**(iii)**
(a)	F	T	T
(b)	T	F	F
(c)	T	F	T
(d)	T	T	F

36. Identify the incorrect statement about frog.

(a) Main digestive glands are liver and pancreas.
(b) There are twelve cranial nerves only.
(c) Cutaneous respiration takes place through skin.
(d) The ventricle opens into the conus arteriosus.

37. Given below are the functions of different parts of the alimentary canal of a cockroach. Correlate these functions with their respective organs.

I. Grinding of food particles
II. Secretion of digestive juices
III. Clearing of haemolymph

The correct set of organs is

(a) I. Malpighian tubule II. Proventriculus III. Hepatic caecae
(b) I. Proventriculus II. Gastric caecae III. Malpighian tubule
(c) I. Gastric caecae II. Gizzard III. Malpighian tubule
(d) I. Gizzard II. Crop III. Malpighian tubule

38. Read the given statement and select the correct option.

Statement I : External ears are absent in frog, only tympanum with internal ears aids in hearing.

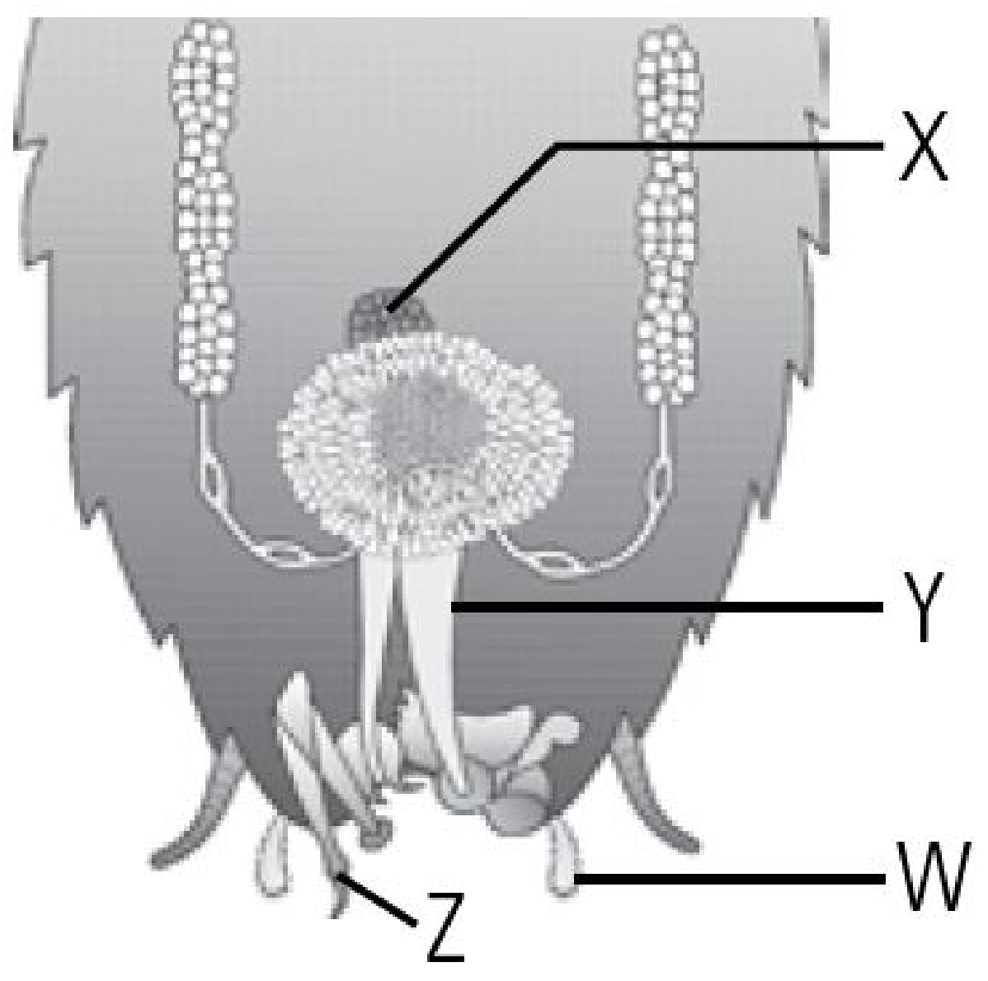
Statement II : The eyes of frog possess single unit hence, are simple.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

39. Muscles involved in movement of arm are

(a) striated
(b) unstriated
(c) cardiac
(d) smooth.

40. Read the given statements and select the option that correctly matches with labelled part W-Z in the given figure.



(i) An elongated muscular tube that opens into male gonopore situated ventral to anus.
(ii) A part of left phallomere that contains hook.
(iii) Secretion of gland forms the outer layer of spermatophore.
(iv) The identifying feature of male cockroach.

(a) (i)-Y, (ii)-Z, (iii)-X, (iv)-W
(b) (i)-Z, (ii)-X, (iii)-Y, (iv)-W
(c) (i)-W, (ii)-Y, (iii)-X, (iv)-Z
(d) (i)-X, (ii)-Z, (iii)-Y, (iv)-W

☺☺

Key is published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted ……
No. of questions correct ……
Marks scored in percentage ……

Check your score! If your score is

> 90%	**EXCELLENT WORK !**	**You are well prepared to take the challenge of final exam.**
90-75%	**GOOD WORK !**	**You can score good in the final exam.**
74-60%	**SATISFACTORY !**	**You need to score more next time.**
< 60%	**NOT SATISFACTORY!**	**Revise thoroughly and strengthen your concepts.**

NCERT XTRACT

This Section Covers Questions Based on Latest **NCERT Textbook** of Class XI

Unit-II : Structural Organisation in Plants and Animals

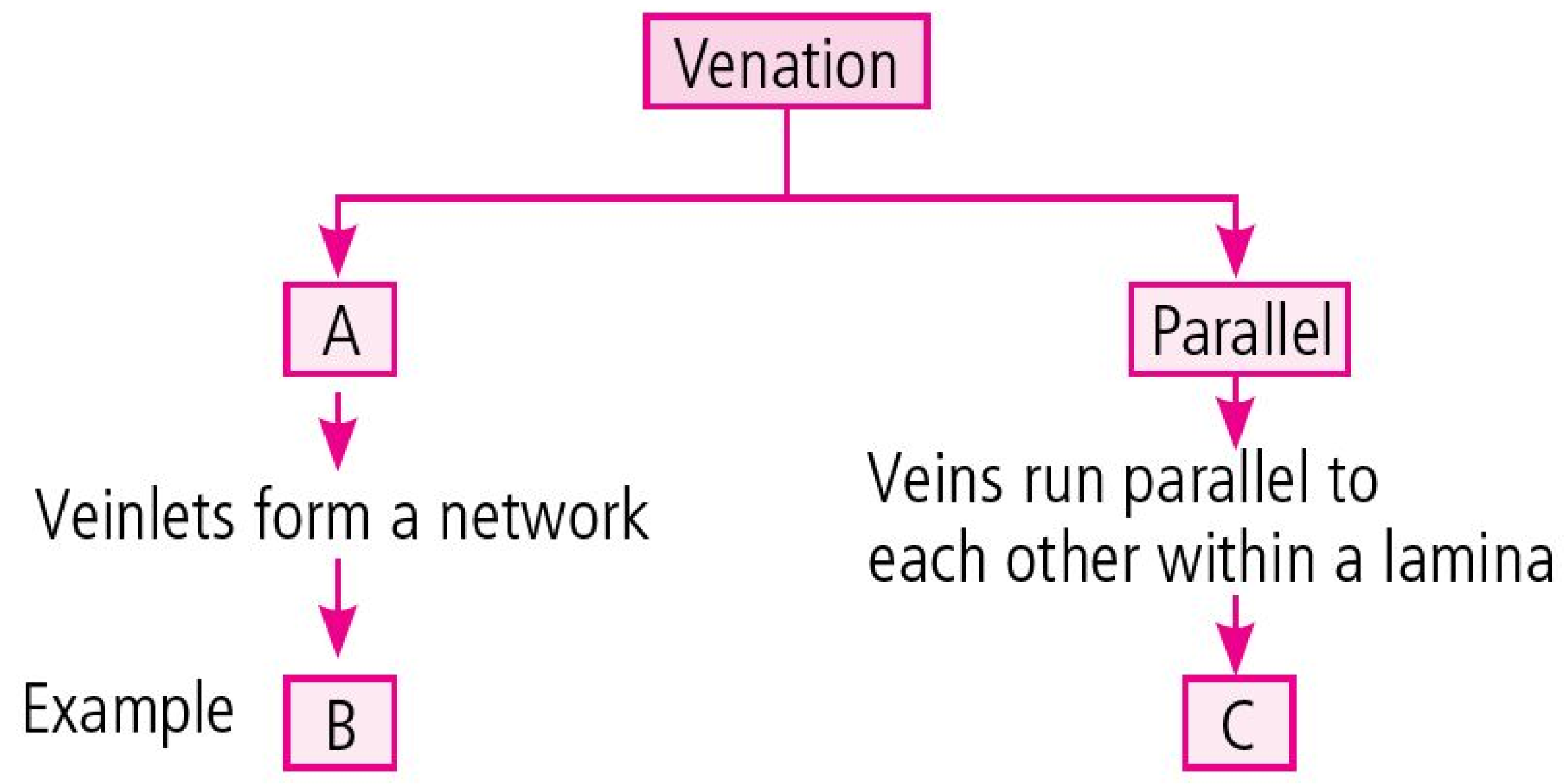
- Morphology of Flowering Plants
- Anatomy of Flowering Plants
- Structural Organisation in Animals

1. Select the correct sequence for the regions of root starting from the root cap.
   (a) Region of meristematic activity → Region of maturation → Region of elongation
   (b) Region of maturation → Region of elongation → Region of meristematic activity
   (c) Region of meristematic activity → Region of elongation → Region of maturation
   (d) Region of elongation → Region of maturation → Region of meristematic activity

2. Root hairs absorb ________ and ________ from the soil.
   (a) carbon dioxide, water
   (b) water, minerals
   (c) oxygen, minerals
   (d) oxygen, water

3. **Assertion (A) :** Some stems store food in them.
Reason (R) : Storage of food is major function of stem.
   (a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
   (b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
   (c) (A) is correct but (R) is not correct.
   (d) (A) is not correct but (R) is correct.

4. The arrangement of veins and veinlets in the lamina is known as venation.



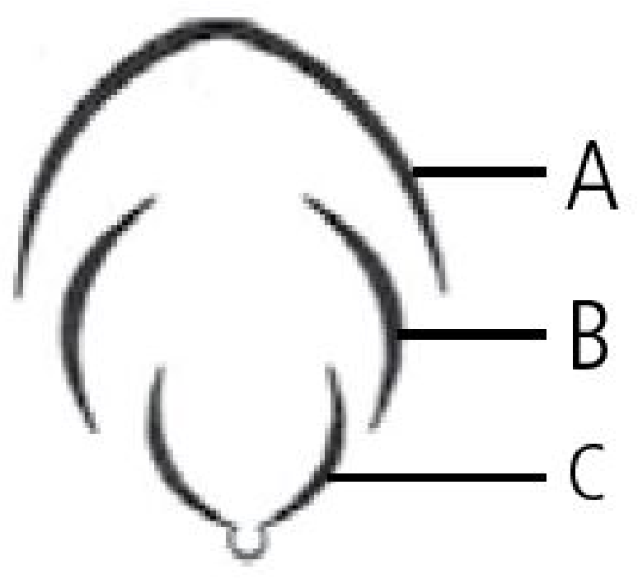
   (a) A – Reticulate, B – Dicots, C – Monocots
   (b) A – Aligned, B – Dicots, C – Monocots
   (c) A – Alternate, B – Monocots, C – Dicots
   (d) A – Opposite, B – Monocots, C – Dicots

5. Select the option that correctly matches the type of phyllotaxy with its character and examples.

S.No.	Phyllotaxy	Character		Example	
(1)	Alternate	A.	A pair of leaves arises at each node contrary to each other.	I.	*Alstonia*
(2)	Opposite	B.	More than 2 leaves arise at node and form a loop.	II.	Mustard
(3)	Whorled	C.	Single leaf arises at each node follow one another.	III.	Guava

   (a) 1-C-III; 2-A-II; 3-B-I
   (b) 1-A-I; 2-B-II; 3-C-III
   (c) 1-B-II; 2-C-III; 3-A- I
   (d) 1-C-II; 2-A-III; 3-B-I

6. Identify the type of petals (A,B and C) in the given diagram.



(a) A-Wings, B-Keel, C-Standard
(b) A-Keel, B-Wings, C-Standard
(c) A-Standard, B-Wings, C-Keel
(d) A-Standard, B-Keel, C-Wings

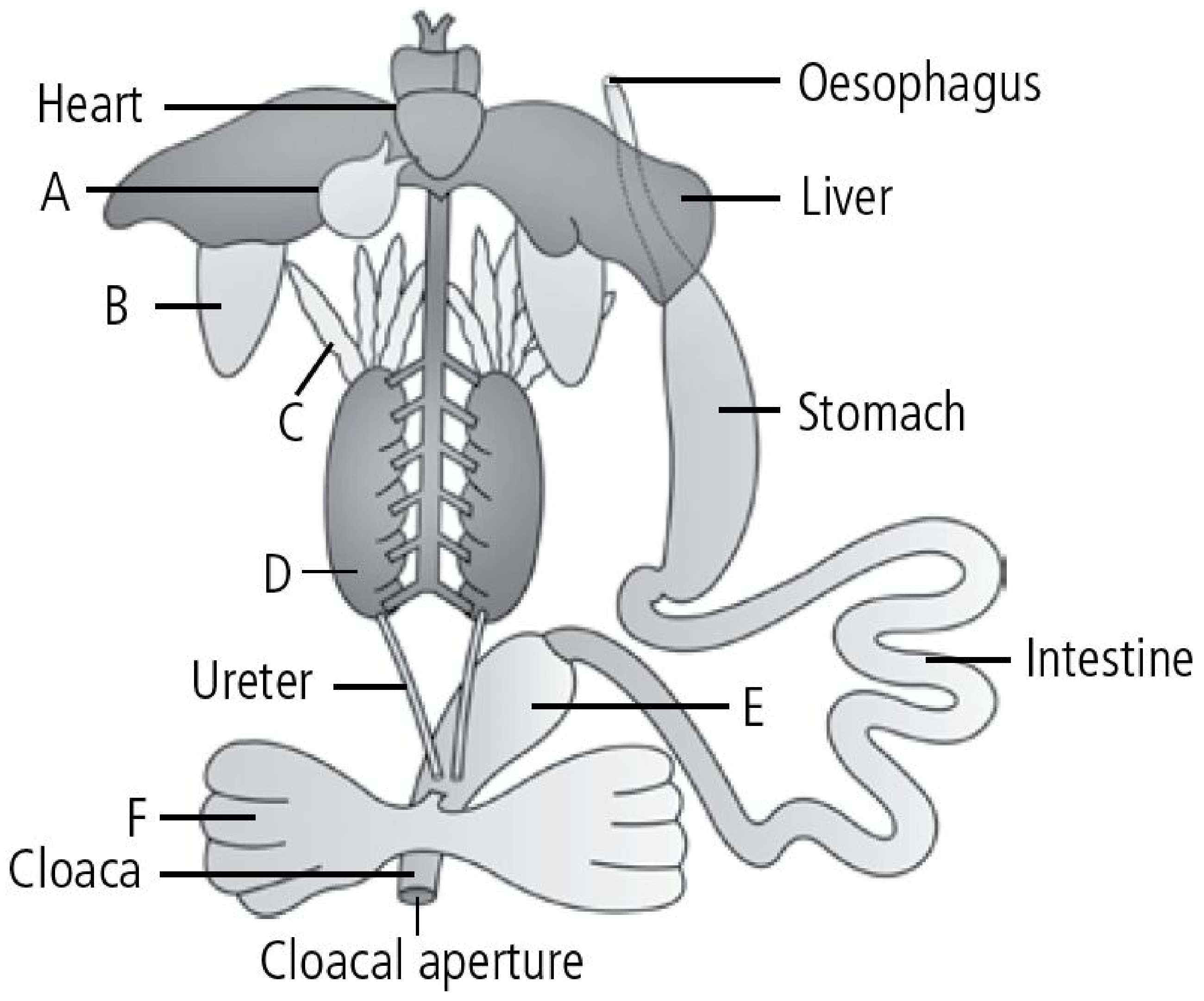
7. The flower are described as hypogynous, perigynous and epigynous on the basis of
(a) position of calyx and corolla *w.r.t.* androecium
(b) position of androecium and gynoecium *w.r.t.* calyx and corolla
(c) position of calyx, corolla and androecium *w.r.t.* gynoecium
(d) number of calyx, corolla and androecium *w.r.t.* gynoecium.

8. Subsidiary cells are the specialised cells in the
(a) vicinity of guard cell
(b) vicinity of stomatal cell
(c) absence of stomatal cell
(d) absence of guard cell.

9. The skin of frog is slippery and smooth due to the presence of
(a) mucus (b) gelatin
(c) waxy skin (d) mucilage.

10. Two cross-sections of stem and root appear simple, when viewed by naked eye. But under microscope, they can be differentiated by
(a) exarch condition of root and stem
(b) endarch condition of stem and root
(c) endarch condition of root and exarch condition of stem
(d) endarch condition of stem and exarch condition of root.

11. Given below is the diagram of internal organs of frog. Identify A to F.



(a) A-Gall bladder, B-Lung, C-Kidney, D-Testis, E-Urethra, F-Urinary bladder
(b) A-Gall bladder, B-Lung, C-Fat bodies, D-Kidney, E-Rectum, F-Urinary bladder
(c) A-Gall bladder, B-Ovary, C-Lung, D-Kidney, E-Ileum, F-Urinary bladder
(d) A-Gall bladder, B-Fat bodies, C-Lung, D-Colon, E-Kidney, F-Urinary bladder

12. Match the following with reference to frog and choose the correct option.

	Column-A		Column-B
(A)	Eyes	1.	Four digits
(B)	Ear	2.	Five digits
(C)	Hind limbs	3.	Tympanum
(D)	Forelimbs	4.	Nictitating membrane

	A	B	C	D
(a)	3	4	2	1
(b)	4	3	2	1
(c)	4	2	3	1
(d)	2	4	3	1

13. Select the characters which are not applicable to the Family Solanaceae?
(i) Epipetalous
(ii) Bicarpellary and syncarpous ovary
(iii) Oblique ovary with axile placentation
(iv) Stamens six, arranged in two whorls
(v) Inferior ovary
(a) (ii) and (iii) only (b) (iv) and (v) only
(c) (ii), (iv) and (v) only (d) (i) and (iii) only

14. Select the mismatched pair.
(a) Fabaceae – Ovary superior
(b) Solanaceae – Vexillary aestivation
(c) Liliaceae – Actinomorphic flower
(d) None of these

15. Radial vascular bundles are characteristic of
(a) monocot root (b) dicot stem
(c) monocot stem (d) monocot leaf.

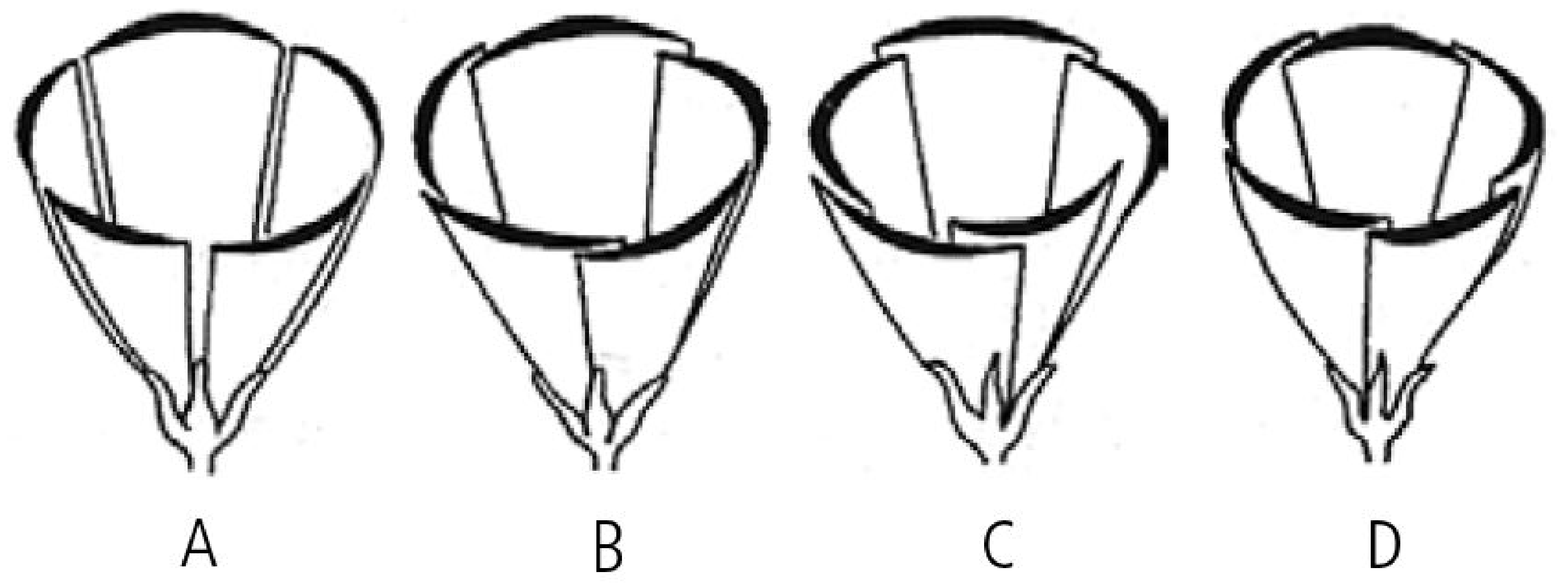
16. Identify the incorrect statement amongst the following.
(a) In frog, the uriniferous tubules are also known as nephrons.
(b) There is no functional connection of ovaries with kidneys in female frog.
(c) Vasa efferentia open into the bidder's canal which finally communicates with urinogenital duct.
(d) A male frog can be distinguished externally from a female frog by the presence of copulatory pad on the first digit of the hindlimb.

Riddle ?

I'm not alive but I can kill. No cell of mine, but I infect at will. Antibiotics don't work on me, yet vaccines can help you be free. What am I?

...search me ☺

17. Refer to the given aestivations (A-D) and select the correct statements regarding them.



I. A is valvate aestivation that occurs in corolla of *Calotropis.*
II. B is vexillary aestivation that occurs in corolla of China rose.
III. D is ascending imbricate aestivation that occurs in petals of *Cassia*.
IV. C is vexillary aestivation that occurs in corolla of Pea.

(a) I and III (b) II and IV
(c) I, II and III (d) All of these

18. Abaxial surface of the leaf generally bears
(a) less stomata than adaxial epidermis
(b) more stomata than adaxial epidermis
(c) stomata equal to adaxial epidermis
(d) hairs to absorb the minerals.

19. In frog, a mature female can lay
(a) 2,500 to 3,000 ova at a time
(b) 1,500 to 2,000 ova at a time
(c) only one ovum at a time
(d) 100 to 200 ova at a time.

20. Select the correct route for the passage of sperms in male frogs.
(a) Testes → Vasa efferentia → Kidney → Seminal vesicle → Urinogenital duct → Cloaca
(b) Testes → Vasa efferentia → Bidder's canal → Ureter → Cloaca
(c) Testes → Vasa efferentia → Kidney → Bidder's canal → Urinogenital duct → Cloaca
(d) Testes → Bidder's canal → Kidney → Vasa efferentia → Urinogenital duct → Cloaca

21. Select the incorrectly matched pair.
(a) Thin walled chloroplast containing cells in ground tissue - Mesophyll cells
(b) Cells of medullary rays that form part of a cambial ring - Interfascicular cambium
(c) Exchange of gases between the outer atmosphere and internal stem tissues - Lenticels
(d) Sclerenchymatous cells are usually present in - Cortex

22. The position of mother axis *w.r.t.* flower is represented by
(a) dot on centre of the floral diagram
(b) dot on top of the floral diagram
(c) dot on the lateral side of floral diagram
(d) dot on all the angles of floral diagram.

23. Read the given statements and mark them as true (T) or false (F).
(A) Flower is the organ involved in sexual reproduction.
(B) A typical flower has 6 type of whorls.
(C) Calyx, corolla, androecium and gynoecium are arranged on receptacle.
(D) Calyx and corolla are reproductive organs.

	A	**B**	**C**	**D**
(a)	F	T	F	T
(b)	T	F	T	F
(c)	F	F	T	T
(d)	T	T	F	F

24. Study the following statements and choose the correct option.
I. Buds are present in the axil of leaflets of the compound leaf.
II. Pulvinus leaf-base is present in some leguminous plants.
III. In *Alstonia*, the petioles expand, become green and synthesise food.
IV. Opposite phyllotaxy is seen in guava.
(a) II and IV are correct but I and III are incorrect.
(b) I and III are correct but II and IV are incorrect.
(c) I and IV are correct but II and III are incorrect.
(d) II, III and IV are correct but I is incorrect.

25. Conjoint vascular bundles are common in
(a) roots (b) stems
(c) leaves (d) both (b) and (c).

26. The lymph of frog lacks
(a) plasma proteins only
(b) WBCs and RBCs
(c) RBCs and few proteins
(d) RBCs, WBCs and proteins.

27. Which of the following represents correct description about frog?
(a) Circulatory system is open type with single circulation.
(b) RBCs are nucleated and have haemoglobin.
(c) Special venous connection between urinary bladder and heart is called hepatic portal system.
(d) The ventricle opens into sinus venosus on the ventral side of the heart.

28. **Assertion :** In opposite phyllotaxy two leaves are borne on the opposite sides of a single node.

Reason : Opposite phyllotaxy is seen in China rose and oleander.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.
(b) Both assertion and reason are true but reason is not the correct explanation of assertion.
(c) Assertion is true but reason is false.
(d) Assertion is false but reason is true.

29. The epidermal hairs present on the stem of the plant are called
(a) trichomes
(b) root hairs
(c) stomata
(d) guard cells.

30. Match the following.

A.	Collenchyma	(i)	Specialised epidermal cells
B.	Subsidiary cells	(ii)	Mechanical support for growing plants
C.	Casparian strips	(iii)	Mesophyll tissue of dicot leaf
D.	Spongy parenchyma	(iv)	Suberin deposition in the radial walls of endodermis

(a) A-(ii), B-(i), C-(iv), D-(iii)
(b) A-(ii), B-(iii), C-(iv), D-(i)
(c) A-(i), B-(ii), C-(iii), D-(iv)
(d) A-(iv), B-(i), C-(ii), D-(iii)

31. Frogs
(a) are uricotelic
(b) have olfactory lobes in the midbrain
(c) do not have renal portal system
(d) have lymphatic system.

32. Read the given statements and select the correct option.
Statement I : Shoot tip transforms into a flower.
Statement II : Flowers are always solitary.
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

33. Mesophyll is a tissue which is present in leaf
(a) between the upper and lower epidermis
(b) below the lower epidermis
(c) in between endodermis and pericycle
(d) below the endodermis and upper on the pericycle.

34. Male frog can be distinguished from female frog by the presence of
(a) vocal sacs and copulatory pad on the first digit of the forelimb
(b) a neck and trunk
(c) the hindlimb that ends in five digits
(d) eyes which are bulged.

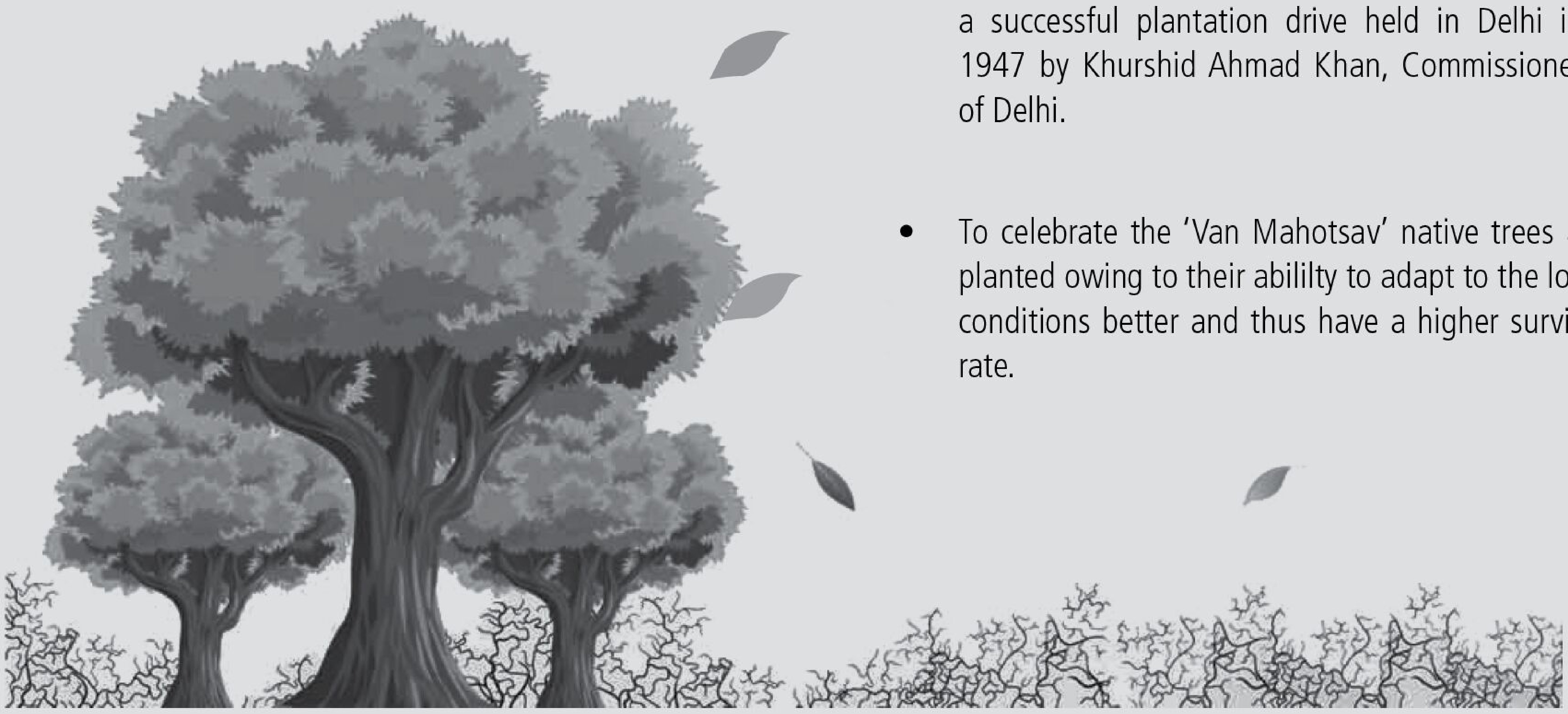
35. Bisexual is a condition in which flower bears
(a) either androecium or gynoecium
(b) staminode and androecium
(c) both androecium and gynoecium
(d) staminode and gynoecium.

36. The most abundant tissues in plants is
(a) meristematic
(b) parenchyma
(c) collenchyma
(d) sclerenchyma.

VAN MAHOTSAV

1st July-7th July

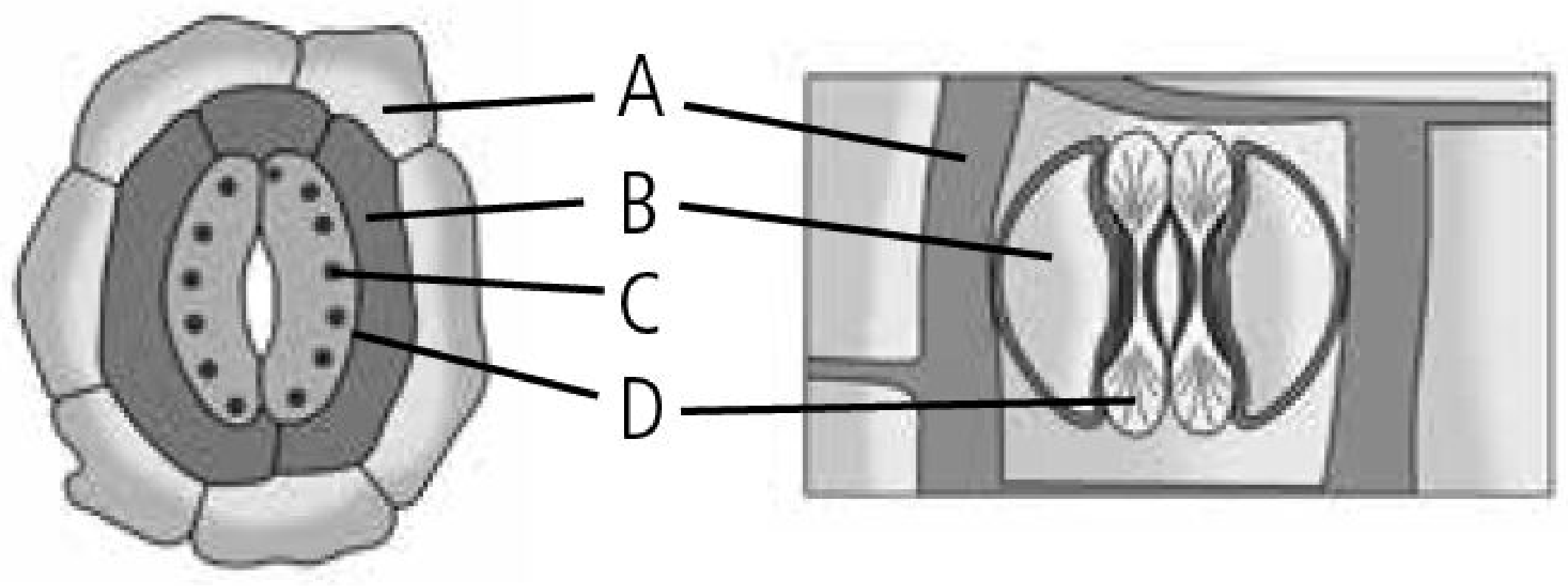
- Van Mahotsav, meaning 'the festival of trees,' emerges as a beacon of hope and action by raising awareness on conservation of trees & emphasising the need for planting trees.
- The Van Mahotsav was launched in 1950, after a successful plantation drive held in Delhi in 1947 by Khurshid Ahmad Khan, Commissioner of Delhi.
- To celebrate the 'Van Mahotsav' native trees are planted owing to their abililty to adapt to the local conditions better and thus have a higher survival rate.



37. The skin of the frog performs major function which is
(a) gaseous exchange but not water absorption
(b) absorb water but not gaseous exchange
(c) absorb water and gaseous exchange
(d) neither absorb water nor gaseous exchange.

38. What does K stands for in floral formula?
(a) Corolla (b) Calyx
(c) Gynoecium (d) Androecium

39. Identify A to D in the given diagrams and choose the correct option.



(a) A-Epidermal cells, B-Guard cells, C-Subsidiary cells, D-Chloroplast
(b) A-Epidermal cell, B-Subsidiary cells, C-Chloroplast, D-Guard cells
(c) A-Epidermal cells, B-Chloroplast, C-Subsidiary cells, D-Guard cells
(d) A-Guard cells, B-Chloroplast, C-Subsidiary cells, D-Epidermal cells

40. Read the given statements and select the correct option.
Statement I : In frog's vascular system, the composition of lymph is same as that of the blood.
Statement II : In frog, lymph lacks RBCs and few proteins.
(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

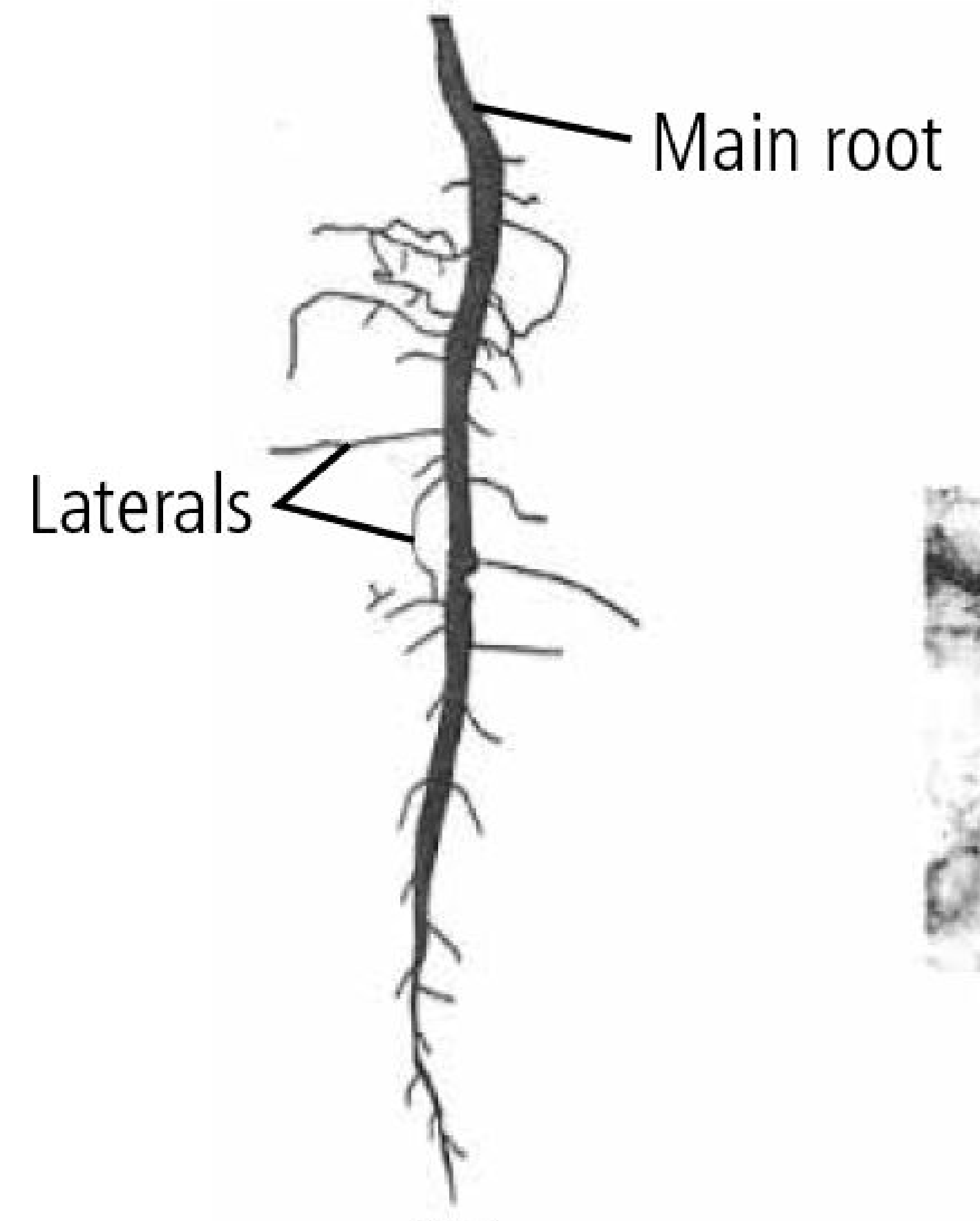
41. **Assertion (A) :** Tap root system is seen in mustard plant.
Reason (R) : In monocotyledonous plants, the primary root is long-lived.
(a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is not correct.
(d) (A) is not correct but (R) is correct.

42. I. Protection of internal tissues.
II. Protection from microbes.
III. Gaseous exchange.
IV. Reduction in the rate of transpiration *via* trichomes.
Which of the function of epidermis is/are relevant from the above given statements?
(a) Only II (b) I and II
(c) II and III (d) I, II, III and IV

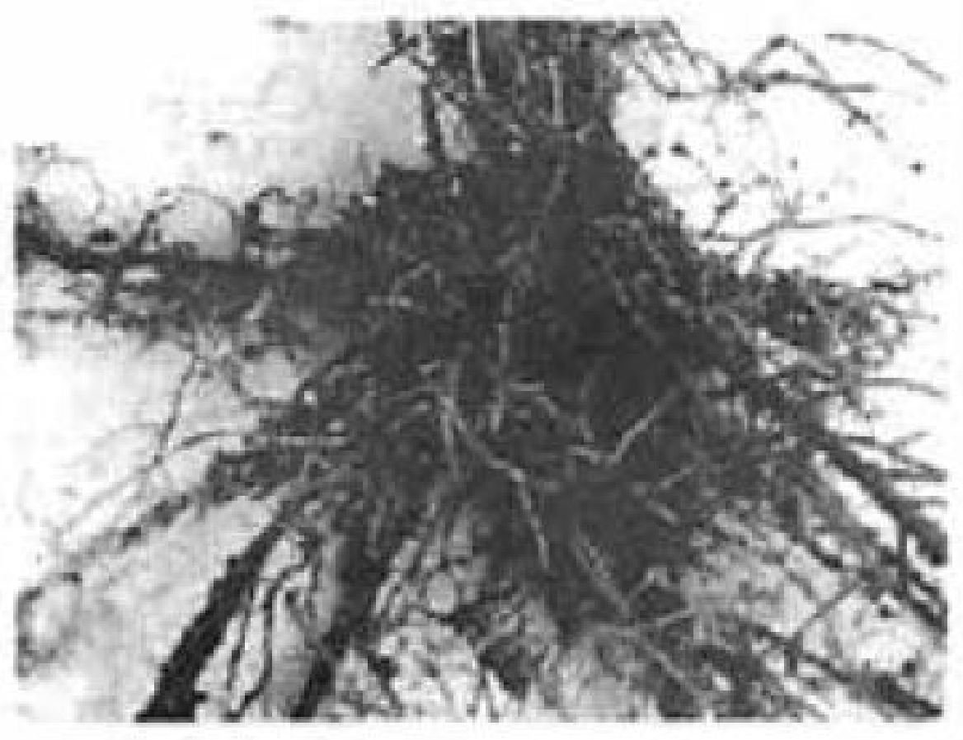
43. Read the statements (A–D) related to the *Rana tigrina*, and select the correct option stating which ones are true (T) and which ones are false (F).
(A) Frogs respire in water by both cutaneous and pulmonary respiration.
(B) Nasal epithelium is a cellular aggregation.
(C) Frogs are ureotelic animals.
(D) In frogs, both male and female sexes are separate.

	A	**B**	**C**	**D**
(a)	T	F	F	T
(b)	T	F	T	F
(c)	T	F	T	T
(d)	F	T	T	T

44. Identify the types of roots in the diagram A and B.



(A)



(B)

(a) A-Fibrous; B-Tap
(b) A-Adventitious; B-Fibrous
(c) A-Fibrous; B-Adventitious
(d) A-Tap; B-Fibrous

45. Which type of vascular bundles are found in monocot stem?
(a) Collateral, open and endarch
(b) Conjoint and closed
(c) Radial, open and mesarch
(d) Collateral, closed and endarch

46. Consider the following statements about frog.
I. Skin acts as a respiratory organ only in water.
II. They possess well-developed renal portal system.
III. External ear is absent in frogs.
IV. Development is indirect and fertilisation is external.
Which of the statements given above is/are incorrect?
(a) Only I (b) I and II
(c) I, II and III (d) II and IV

47. From the options given below, find out the correct floral formula for a flower having the following characters namely actinomorphic, bisexual, five united sepals, five united petals, stamens five and epipetalous, bicarpellary, syncarpous with superior ovary.
(a) $\oplus ⚥ K_{(5)}C_{(5)}A_5\underline{G}_{(2)}$ (b) $\oplus ⚥ K_{(5)}\overgroup{C_{(5)}A_5}\underline{G}_{(2)}$
(c) $\oplus ⚥ K_{(5)}C_{(5)}A_{(5)}\underline{G}_{(2)}$ (d) $\oplus ⚥ K_{(5)}\overgroup{C_{(5)}A_{(5)}}\overline{G}_{(2)}$

48. Match column I with column II.
Column I **Column II**
1. Dicot stem (I) Radial, open

2. Dicot root (II) Radial, exarch xylem
3. Monocot root (III) Conjoint open, endarch
4. Monocot stem (IV) Conjoint, closed

(a) 1-I, 2-III, 3-IV, 4-II (b) 1-III, 2-II, 3-IV, 4-I
(c) 1-I, 2-IV, 3-II, 4-III (d) 1-III, 2-I, 3-II, 4-IV

49. Read the given statements and select the correct option.
Statement I : Frogs cannot maintain a constant body temperature.
Statement II : Frogs shows camouflage to hide from their enemies.

(a) Both statement I and statement II are correct.
(b) Both statement I and statement II are incorrect.
(c) Statement I is correct but statement II is incorrect.
(d) Statement I is incorrect but statement II is correct.

50. The tympanum of a frog represents
(a) small bone in middle ear
(b) center of retina for bright vision
(c) a pair of membranous structure to receive sound signals
(d) an organ to regulate body temperature.

SOLUTIONS

1. (c)

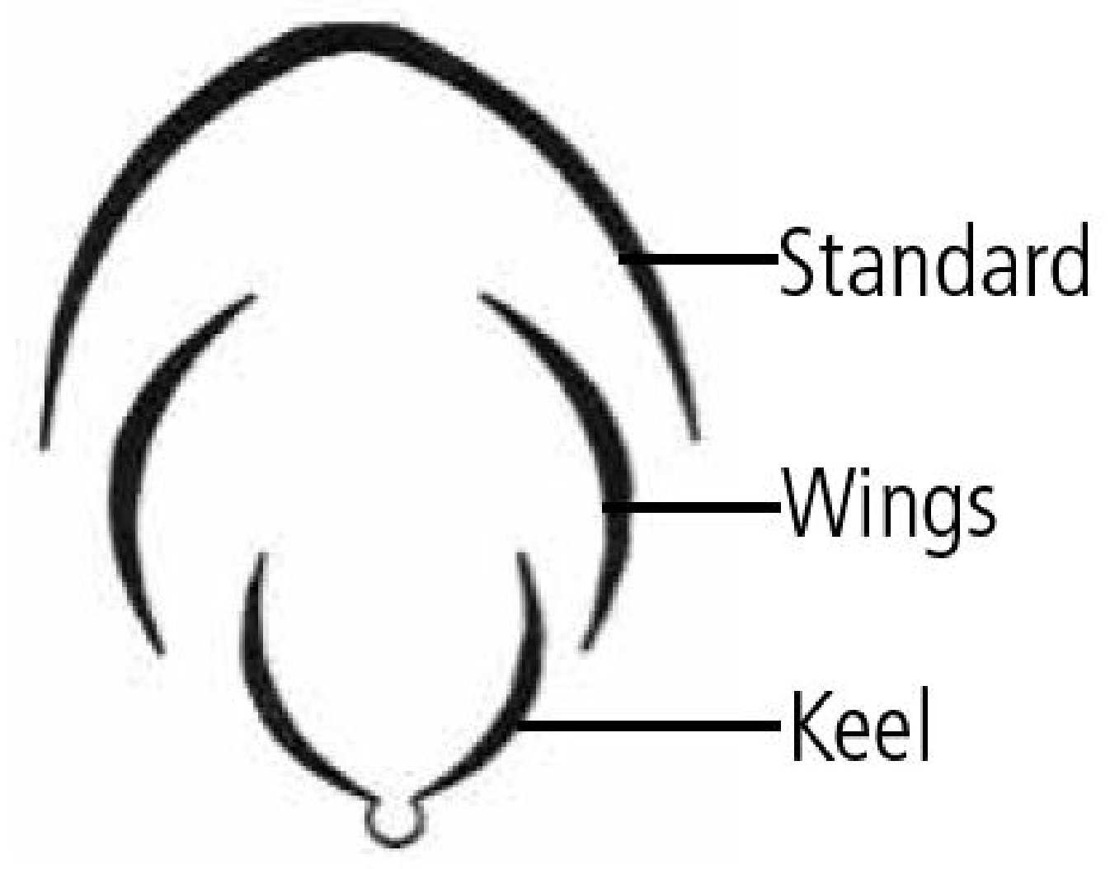
2. (b) : Root hairs absorb water and minerals from the soil.

3. (c)

4. (a) : Venations are of two types *i.e.*, reticulate and parallel. Here, A is reticulate venation, B is mango (dicot) and C is wheat (monocot).

5. (d)

6. (c) : In pea and bean flowers, there are five petals, the largest (standard) ovarlaps the two lateral petals (wings) which in turn overlap the two smallest anterior petals (keel); this type of aestivation is known as vexillary or papilionaceous.



7. (c) : The flowers are described as hypogynous, perigynous and epigynous on the basis of position of calyx, corolla and androecium *w.r.t.* gynoecium.

8. (a) : Sometimes, a few epidermal cells, in the vicinity of the guard cells become specialised in their shape and size and are known as subsidiary cells.

9. (a) : The skin of frog is naked, *i.e.*, without scales or feathers, smooth and slippery due to the presence of sac-like mucus gland that discharges slimy mucus onto the epidermis.

10. (d) : Characteristic feature of stem is endarch condition of xylem tissue. In endarch, protoxylem is present towards the centre of stem, while metaxylem towards the periphery. Characteristic feature of root is exarch condition of xylem tissue. In exarch condition, protoxylem is present towards the periphery and metaxylem towards the centre of the root.

11. (b) **12. (b)**

13. (b) : The characters of solanaceae are : androecium consists of five stamens, stamens are free, epipetalous, anthers bithecous, dehiscence longitudinal. Gynoecium consists of bicarpellary, syncarpous, superior ovary, carpels placed obliquely, generally bilocular, placentation axile, placentae swollen.

14. (b)

15. (a) : Radial vascular bundles are characteristic feature of both monocot and dicot roots. In radial vascular bundles, the xylem and phloem are located at different radii from the center of the bundle.

16. (d) : A male frog can be distinguished by the presence of sound producing vocal sacs and also a copulatory pad on the first digit of the forelimbs which are absent in female frogs.

17. (a) : B shows twisted or contorted aestivation in which one margin of a petal overlaps regularly the margin of an adjacent petal, the other margin being overlapped by margin of another overlapped by of another adjacent petal *e.g.*, corolla of China rose. C represents imbricate aestivation in which two petals external, two internal and fifth with one margin external while its other margin is internal.

18. (b) : The abaxial epidermis generally bears more stomata than the adaxial epidermis.

19. (a)

20. (c) : The correct route for transport of sperms in male frog is Testes → Vasa efferentia → Kidney → Bidder's canal → Urinogenital duct → Cloaca.

21. (d) **22. (b)**

MONTHLY TEST DRIVE CLASS XI ANSWER KEY

1.	(d)	**2.**	(b)	**3.**	(b)	**4.**	(c)	**5.**	(d)
6.	(d)	**7.**	(a)	**8.**	(a)	**9.**	(d)	**10.**	(d)
11.	(a)	**12.**	(a)	**13.**	(b)	**14.**	(a)	**15.**	(a)
16.	(b)	**17.**	(a)	**18.**	(a)	**19.**	(c)	**20.**	(c)
21.	(d)	**22.**	(a)	**23.**	(b)	**24.**	(d)	**25.**	(d)
26.	(d)	**27.**	(a)	**28.**	(a)	**29.**	(c)	**30.**	(a)
31.	(c)	**32.**	(d)	**33.**	(a)	**34.**	(b)	**35.**	(c)
36.	(b)	**37.**	(b)	**38.**	(a)	**39.**	(a)	**40.**	(a)

23. (b) : A typical flower has four different kinds of whorls. Calyx and corolla are accessory organs.

24. (a) : In some legumes the leaf base may become swollen, which is called the pulvinus. In opposite phyllotaxy, a pair of leaves arises at each mode and lie opposite to each other as in *Calotropis* (akon/madar) and guava (*Psidium*) plants.

25. (d) : When xylem and phloem within a vascular bundle are arranged in an alternate manner on different radii, the arrangement is called radial, such as in roots. In conjoint type of vascular bundles, the xylem and phloem are situated at the same radius of vascular bundles. Such vascular bundles are common in stems and leaves. The conjoint vascular bundles usually have the phloem located only on the outer side of xylem.

26. (c)

27. (b) : Frogs have closed circulatory system. The ventricles open into sac like structure called conus arteriosus. Hepatic portal system is present between liver and intestine.

28. (c) : In opposite phyllotaxy, two leaves are borne on the opposite sides of a single node *e.g.*, *Quisqualis* (opposite and superposed) and *Calotropis* (opposite and decussate). *Nerium* or oleander shows whorled type of phyllotaxy and China rose exhibits alternate phyllotaxy.

29. (a) : Trichomes are epidermal outgrowths present temporarily or permanently on almost all plant parts especially stems. These may be unicellular or multicellular and vary in size and shape in different species.

30. (a)

31. (d) : Frogs are ureotelic, *i.e.*, they excrete urea as their nitrogenous waste. Two olfactory lobes are present in the forebrain of frog. They have renal portal system in which the blood from the hind parts of the body goes into post caval and then to the heart after getting filtered in the kidneys. Lymphatic system of frogs comprises of lymph, lymph capillaries, lymph sinuses and lymph heart. Liver secretes bile which is transferred to the gall bladder for storage through many hepatic ducts.

32. (c)

33. (a) : The tissue between the upper and the lower epidermis is called the mesophyll. Mesophyll possesses chloroplasts and carry out photosynthesis.

34. (a) : Male frog can be distinguished from female frog by the presence of vocal sacs and copulatory pad on the first digit of the forelimb.

35. (c) : When a flower has both androecium and gynoecium, it is said to be bisexual.

36. (b) : Parenchyma is the most abundant and common tissue of the plants. Parenchyma forms ground tissue in the non-woody or soft areas of the stem, leaves, roots, flowers, fruit, etc. The typical parenchyma is meant for storage of food. It is modified to performs special functions.

37. (c) : The skin of frog is smooth and highly vascularised. It helps in absorbing water and gaseous exchange.

38. (b) : In floral formula K stands for calyx, C for corolla, A for androecium and G for gynoecium.

39. (b)

40. (d) : In frogs vascular system, the composition of lymph is different from that of blood. Blood consists of fluid, plasma and three types of corpuscles (RBCs, WBCs and platelets) dissolved in it.

However, lymph is a fluid filtered out from the blood through capillaries. It lacks RBCs and some proteins. Thus, it differs from blood in composition.

41. (c)

42. (d) : The epidermis performs various functions like the protection of internal tissue. The stomata in the epidermis helps in gaseous exchange and the trichome helps in the reduction of transpiration rate.

43. (d) : In water, frog respires through skin (cutaneous respiration).

44. (d) : Primary roots and its branches constitutes the tap root system as seen in mustard plant (figure A).

Roots originate from the base of the stem and constitute the fibrous root system as seen in wheat plant (figure B).

45. (b)

46. (a) : Frogs respire on land and in water differently. In water, skin acts as respiratory organ. On land, inspite of skin the buccal cavity and lungs majorly act as respiratory organs. Pulmonary respiration occurs on land through lungs.

47. (b) **48. (d)**

49. (a) : Frogs do not have constant body temperature, *i.e.*, their temperature varies with the temperature of the environment such animals are called cold blooded or poikilotherms. They have the ability to change colour to hide them from their enemies (camouflage).

50. (c) : The tympanum of a frog represents a pair of membranous structure to receive sound signals.

☺☺

UNSCRAMBLED WORDS

JUNE 2025

1-d- INDUCER
2-j-COLOSTRUM
3-a- CATABOLISM
4-f-MELATONIN
5-i- PROTONEMA
6-b-MYOFIBRILS
7-h-METHANOGENS
8-g-OVULATION
9-c-ANTENNAE
10-e-DITHECOUS

***Winner :** Priya Gupta, Haryana*

CLASS 12

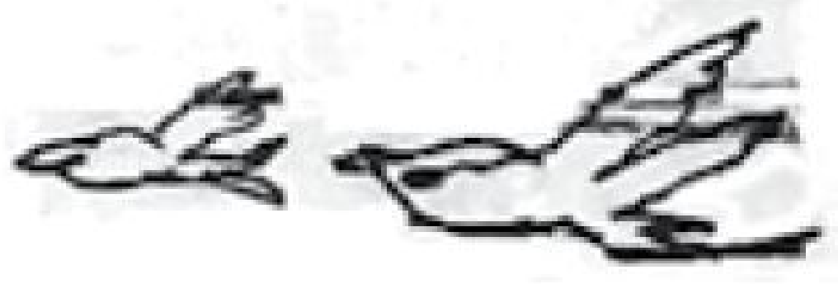
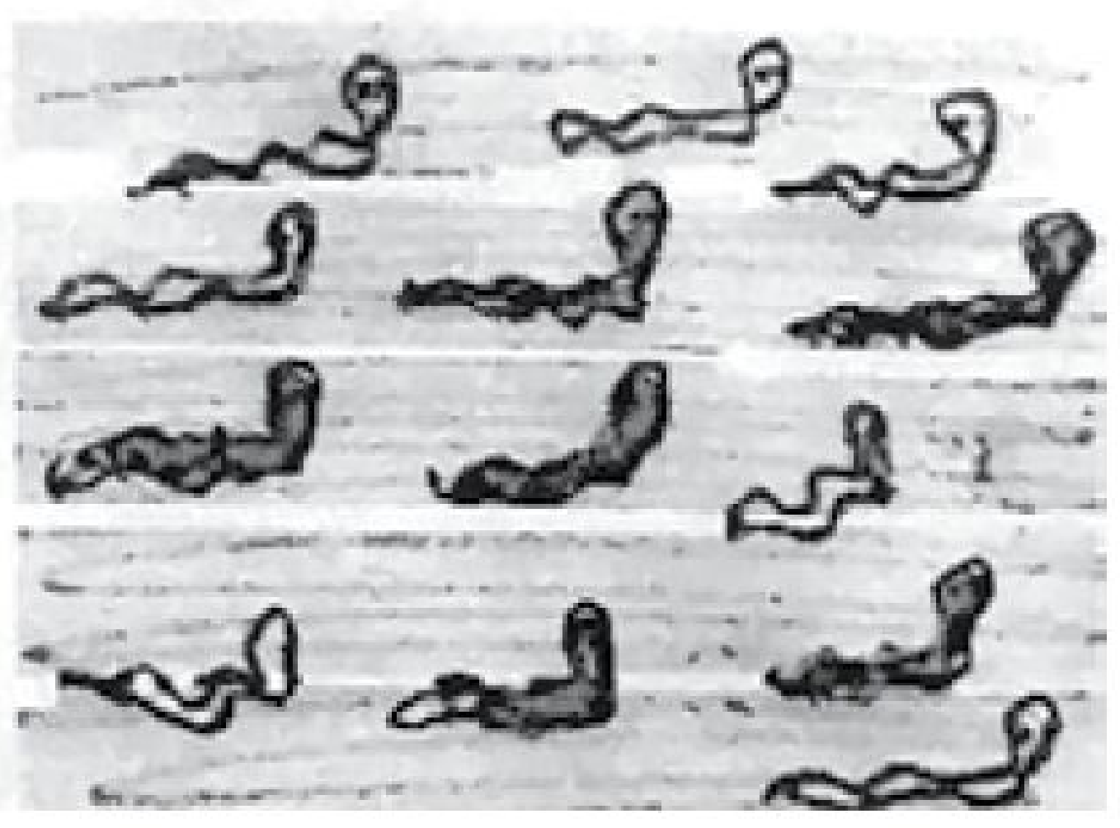
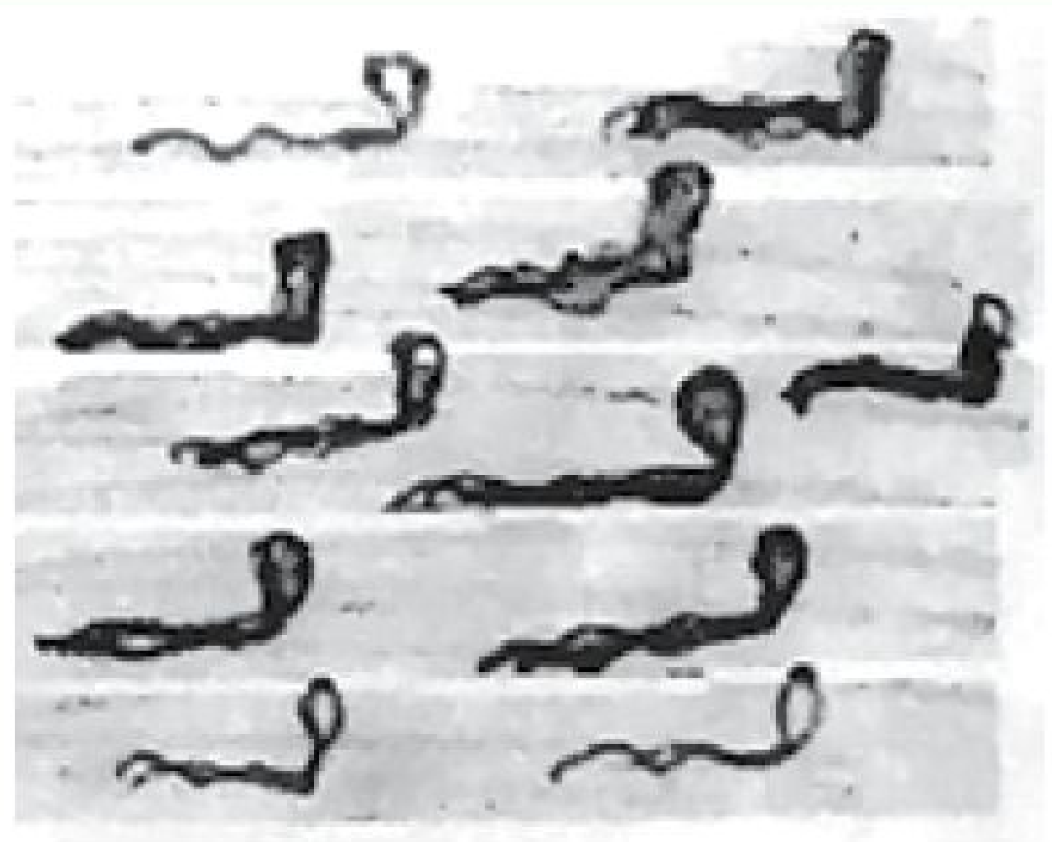
CFQs

COMPETENCY FOCUSED QUESTIONS

Practice Time

CASE BASED QUESTIONS

1. A population of snakes lived in a desert with brown sand. Study the drawings given below showing the change in the population from 'one' to 'two' over time and answer the question that follows. Brown snakes and grey snakes are represented by alleles A/a (Dominant/recessive).

Population-one	Population-two (Migration of birds)
	
	

(a) If the frequency of the recessive trait is 9% in population-one, work out the frequency of homozygous dominant and heterozygous dominant snakes.

(b) Name the mechanism of evolution that must have operated so that population-two evolved from population-one.

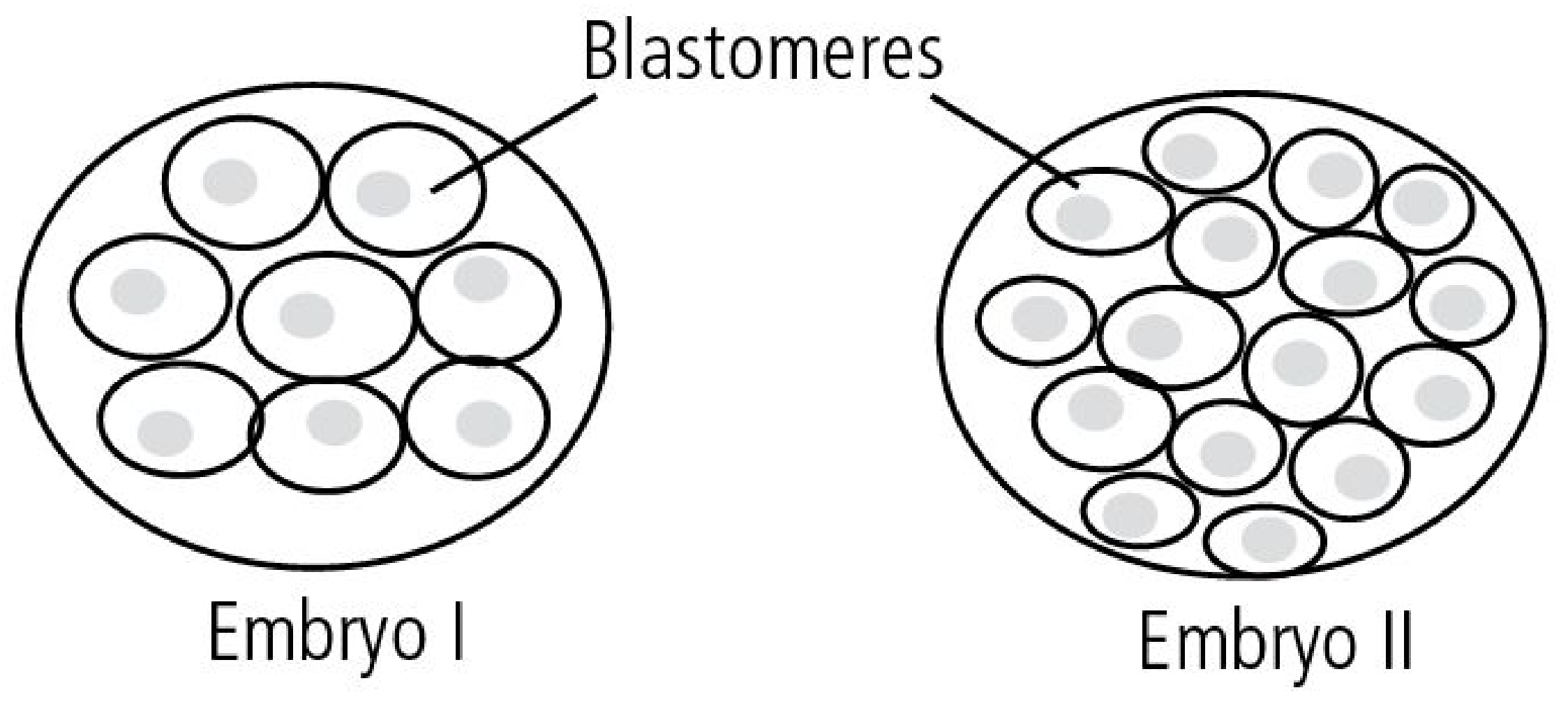
2. Cryptorchidism is a condition in which the testes fail to descend into the scrotum. It can also lead to compromised Sertoli cell function and has an impact on Leydig cell function.

(i) Identify at least 3 parameters of male fertility which get affected due to cryptorchidism.

(ii) Which process will be affected if mature spermatids are not released from Sertoli cells?

(iii) Name and explain one assisted reproductive technology (ART process) in which the sperm/semen is used to assist fertilisation.

(iv) Name and explain the assisted reproductive technology that should be used to complete the development of embryos I and II shown in the figure given below.



3. Read the passage given below and answer the following questions.

Disposal of untreated sewage into the river or freshwater pond causes huge water pollution. Four water samples from different sources (A, B, C, D) are collected and tested for BOD value in a lab to assess their quality. The BOD values are presented in the given table. Water samples are collected from primary effluent, secondary effluent, untreated sewage and river water.

Sample	BOD
A	20 mg/L
B	5 mg/L
C	300 mg/L
D	400 mg/L

(i) The source of sample 'C' is
(a) river water
(b) primary effluent
(c) secondary effluent
(d) untreated sewage water.

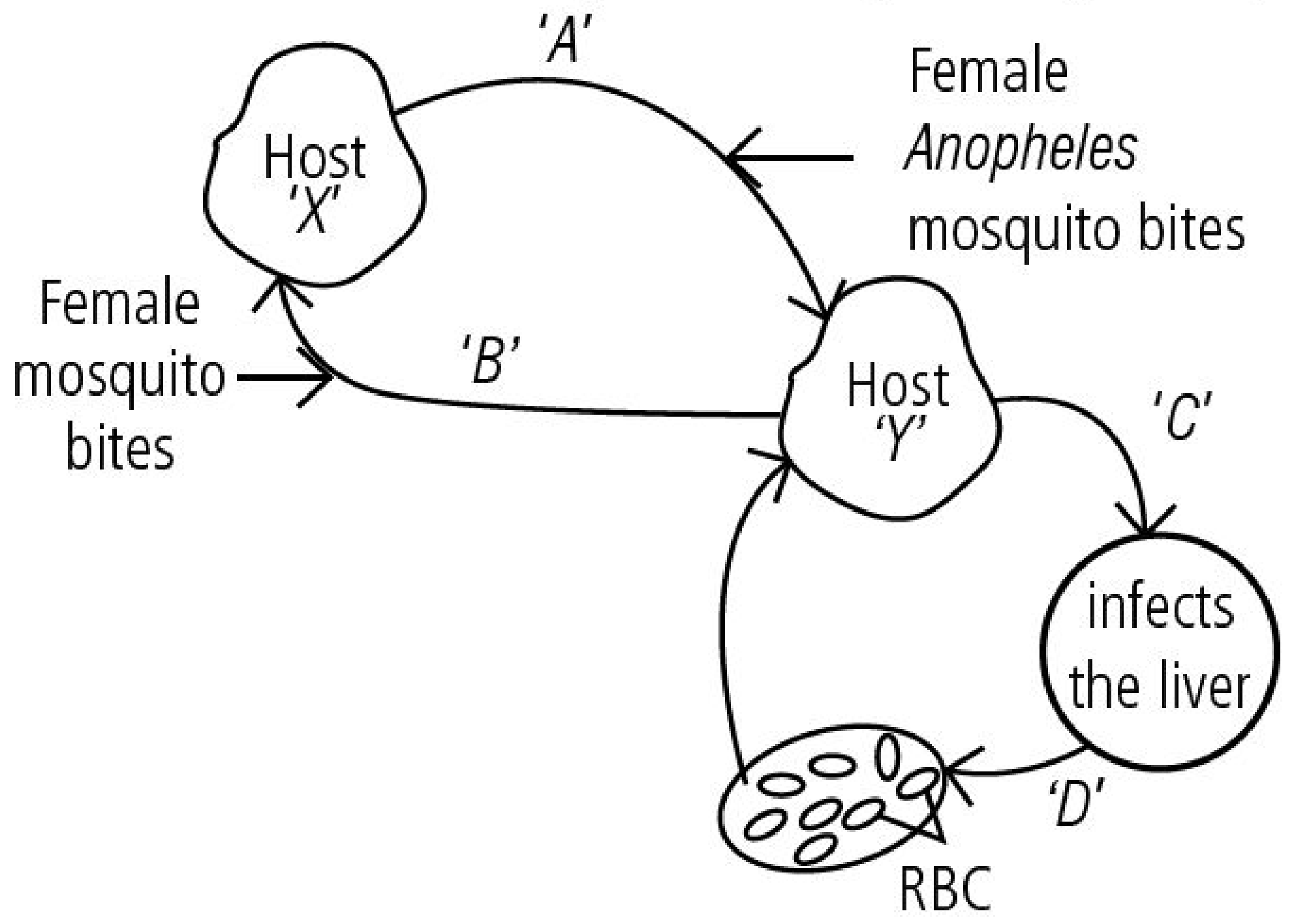
(ii) If sewage in untreated condition is disposed off in a freshwater body then,
(a) BOD and dissolved oxygen both will increase
(b) BOD will increase and dissolved oxygen will decrease
(c) BOD will decrease and dissolved oxygen will increase
(d) BOD and dissolved oxygen both will decrease.

(iii) A large number of pathogenic microbes can be present in water sample of
(a) sample C (b) sample A
(c) sample D (d) both sample C and D.

(iv) High value of BOD in sample D is due to
(a) high amount of organic wastes and aerobic microbes
(b) high amount of inorganic wastes and anaerobic microbes
(c) high amount of organic wastes and anaerobic microbes
(d) high amount of inorganic wastes and aerobic microbes.

(v) River water is represented by the sample
(a) sample A
(b) sample B
(c) sample C
(d) sample D.

4. Read the following and answer the questions from 6(i) to 6(iv).
The diagram shows the life cycle of a pathogenic protozoan.



(i) Name the parasitic stage that is being transferred from host '*X*' to host '*Y*'.

(ii) Write the changes the parasite undergoes in the liver.

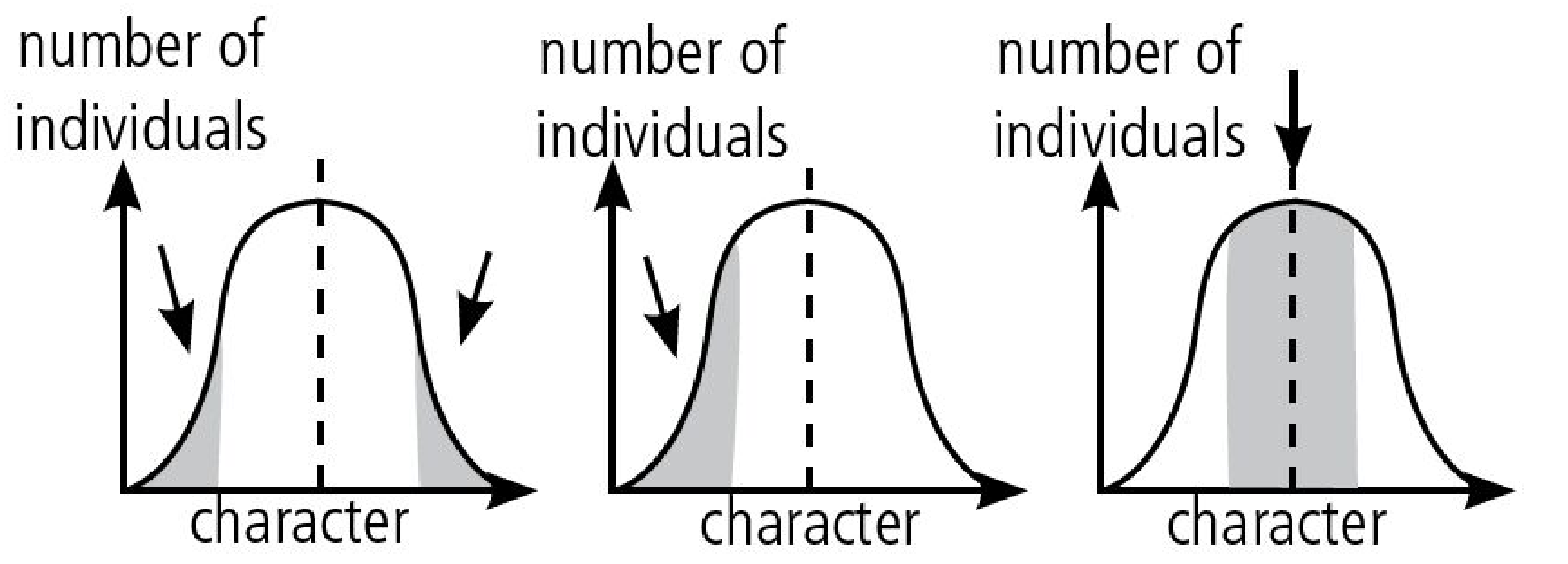
(iii) Write the changes the parasite undergoes when it enters the RBC.

(iv) Trace the changes the parasite undergoes when the host '*X*' takes its blood meal from infected host '*Y*'.

OR

(iv) At which stage during the life cycle of the pathogen does the host '*Y*' experience the symptoms of the disease? Name the disease and the toxic substance responsible for these symptoms.

5. The graphs below show three types of natural selection. The shaded areas marked with arrows show the individuals in the population which are not selected. The dotted vertical lines show the statistical means.

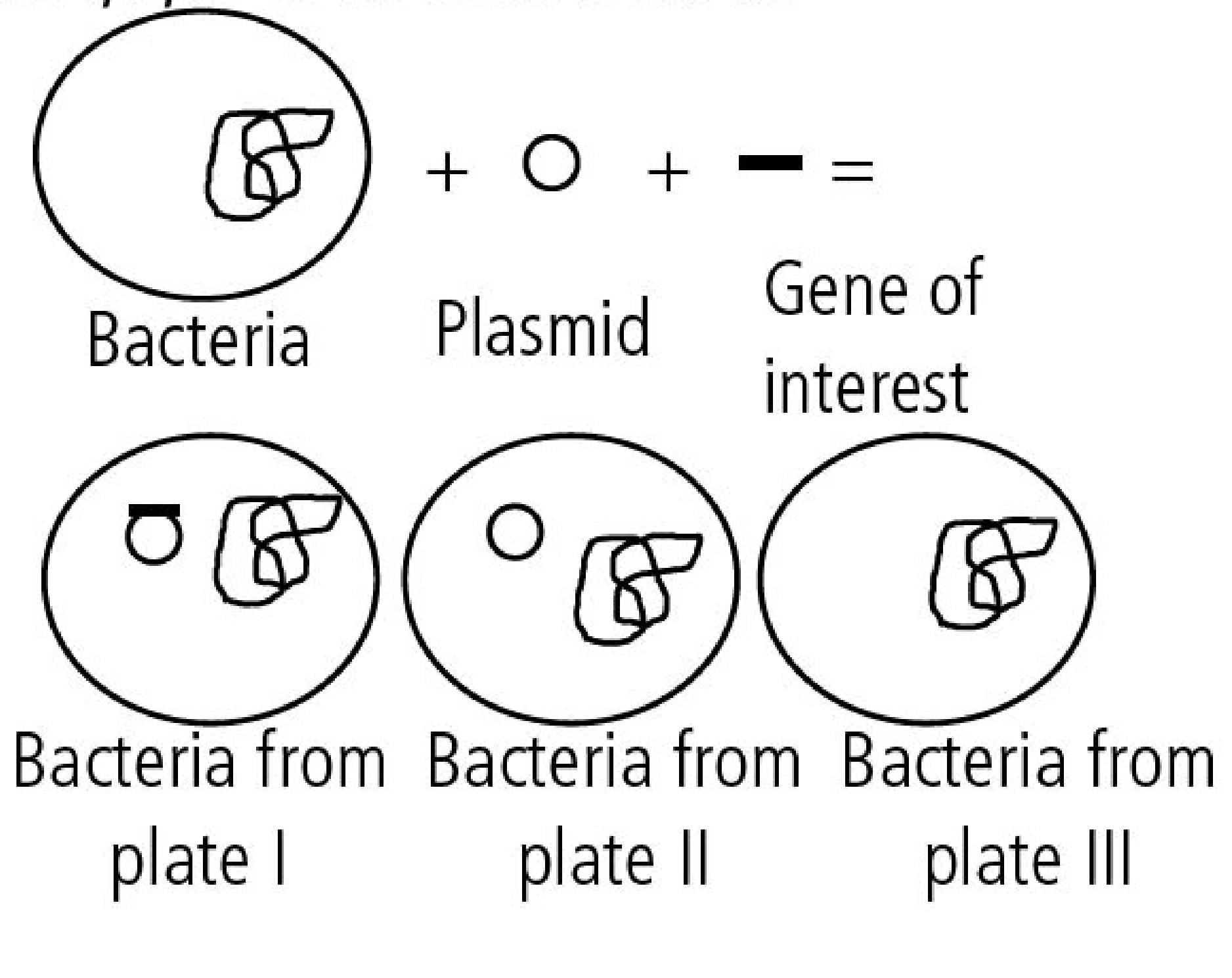


Graph A Graph B Graph C

(a) What names are given to the types of selection shown in graphs A, B and C?

(b) After the selection has operated for several generations in the above populations indicated as graph A, B and C, graphically illustrate the probable results.

6. The image below shows the result of plating bacteria in chromogenic medium after incorporating the gene of interest in plasmid. Some plates had blue colonies; some plates had white colonies. A single bacterium extracted from Plate I,II,III is shown below:

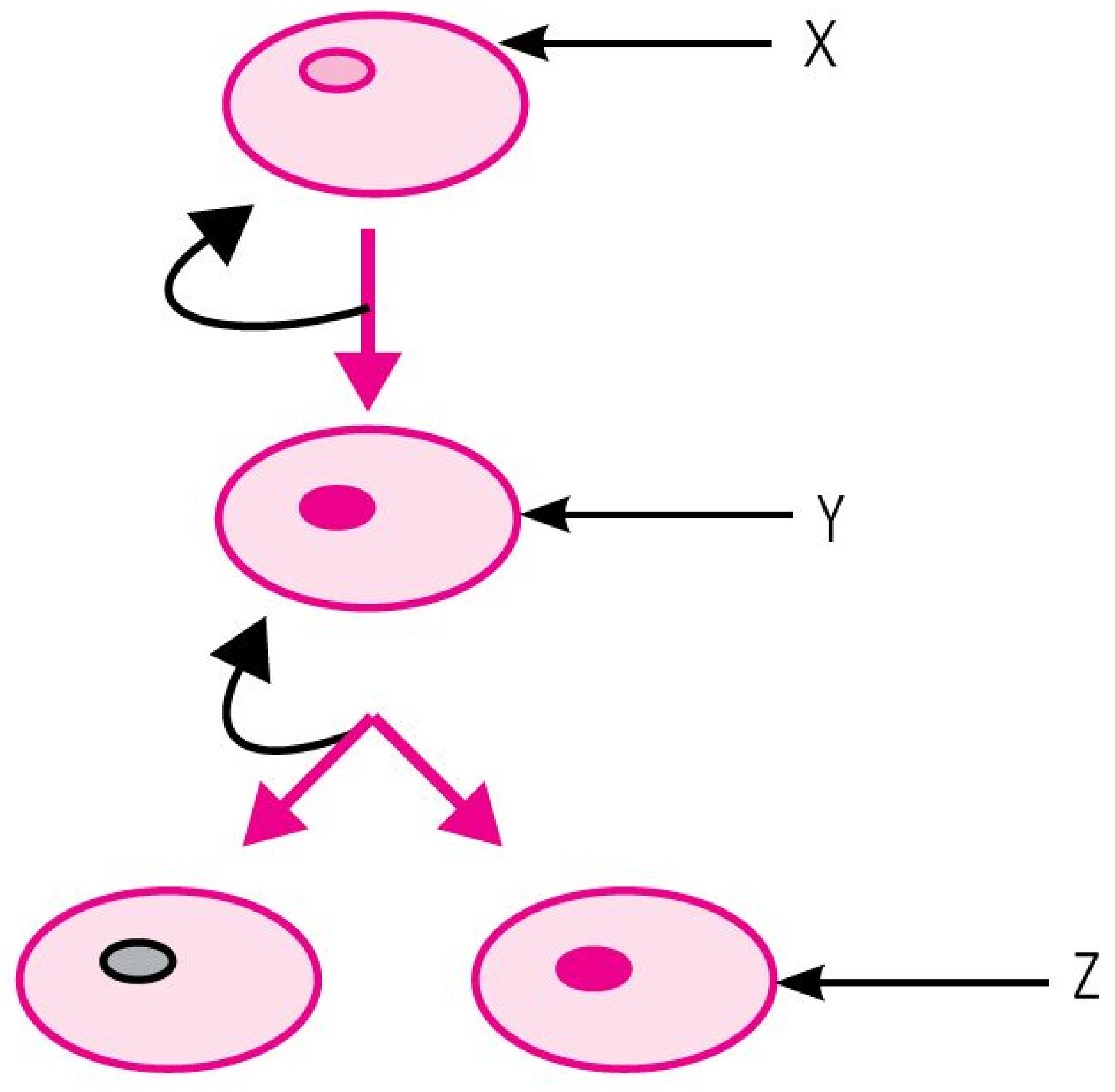


On the basis of your observations

(a) Identify the plate(s) which is/are white. Give a reason.

(b) Identify the plate(s) which is/are blue. Give a reason.

7. Refer to the given diagram and answer the questions that follow.



Stem cells are unique cells with the ability to differentiate into specialised cell types. Based on their potential to develop into different cell types, they are classified into three main categories: X, Y, and Z stem cells.

X cells have unlimited capability and have the ability to form extraembryonic membranes and tissues, the embryo itself and all post-embryonic tissues and organs. Y cells can give rise to most, but not all, tissues of an organism. Blood stem cells are the example of Z cells.

(i) Which type of stem cell is represented as X?

(ii) Which conclusion is correct regarding the differentiation potential of Z cells?

(iii) What type of cells are crucial in therapeutic applications such as tissue regeneration and disease treatment?

OR

(iv) Scientists extract Y cells from a blastocyst. These cells containing tissues that can form all three germ layers ectoderm, mesoderm and endoderm. Identify Y cells.

8. A team of ecologists studied three ecosystems – X, Y and Z – to analyse the structure of their ecological pyramids.

In X, a single producer supported multiple primary consumers, which in turn provided nutrition to several secondary consumers and these secondary further supported tertiary consumers.

In Y, the producers have the least biomass and their consumers had a higher biomass, making the system stable. In Z, the number of producers is the highest and the number of organisms gradually decreased at each successive trophic level. Despite these variations in numbers and biomass, the energy transfer pattern followed a consistent trend across all ecosystems.

(a) What type of pyramid does X represent? Give your answer with a reason.

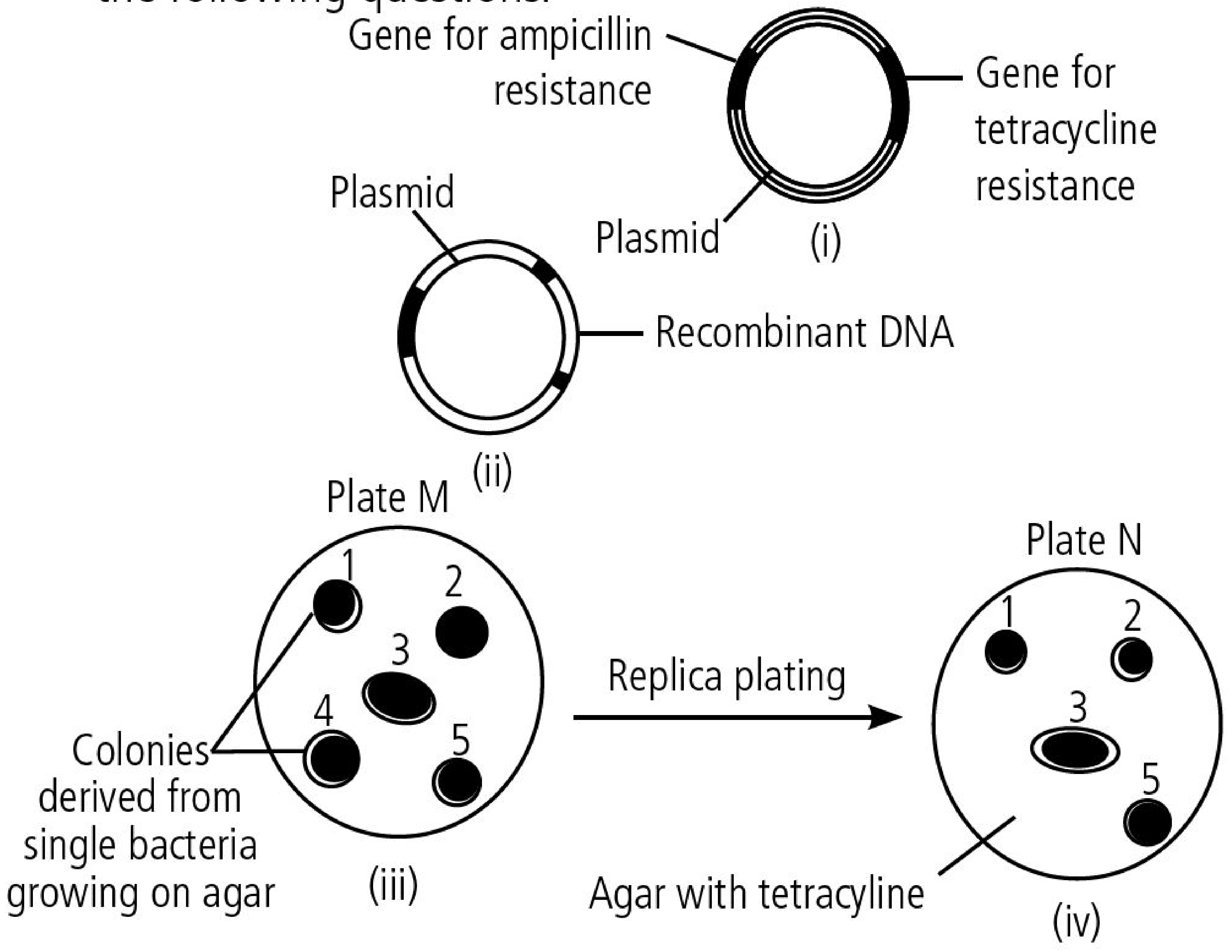
(b) What type of pyramid initially depict if a predator for the zooplankton exclusively introduce into the Y ecosystem?

(c) Which of the given ecosystems always has an upright pyramid and why?

OR

(c) Mention the one common similarity among the pyramids of all three ecosystems.

9. Read the given passage and answer the following questions. Analyse the given diagram which shows steps involved in the procedure of selecting transformed bacteria and answer the following questions.


Gene for ampicillin resistance
Gene for tetracycline resistance
Plasmid
Plasmid
(i)
Recombinant DNA
(ii)
Plate M
1
2
3
4
5
Colonies derived from single bacteria growing on agar
(iii)
Replica plating
Plate N
1
2
3
5
Agar with tetracyline
(iv)

(a) During the experiment, bacterial colony 4 was able to grow on plate M but failed to grow on plate N. Give the reason behind this observation.

(b) Which among the following colonies is/are non-transformant?

(c) What is the purpose of replica plating in this experiment? How does it help in selecting transformed bacteria?

(d) What will be the impact, if foreign gene is inserted somewhere else instead of the destined restriction site (marker *tet*^{R}) in plasmid?

10. Read the passage given below and answer the following questions.

'X' is a technique of determining nucleotide sequences of certain areas of DNA which are unique to each individual. Each person has a unique sequence. Each nucleotide sequence is the same for every cell, tissue and organ of a person. This technique is the basis of paternity testing in case of disputes.

(i) Identify the technique developed to identify a person with the help of DNA restriction analysis.
(a) DNA profiling (b) DNA fingerprinting
(c) RFLP (d) Both (a) and (b)

(ii) For technique X, DNA is obtained from
(a) blood (b) hair root cells
(c) semen (d) all of these.

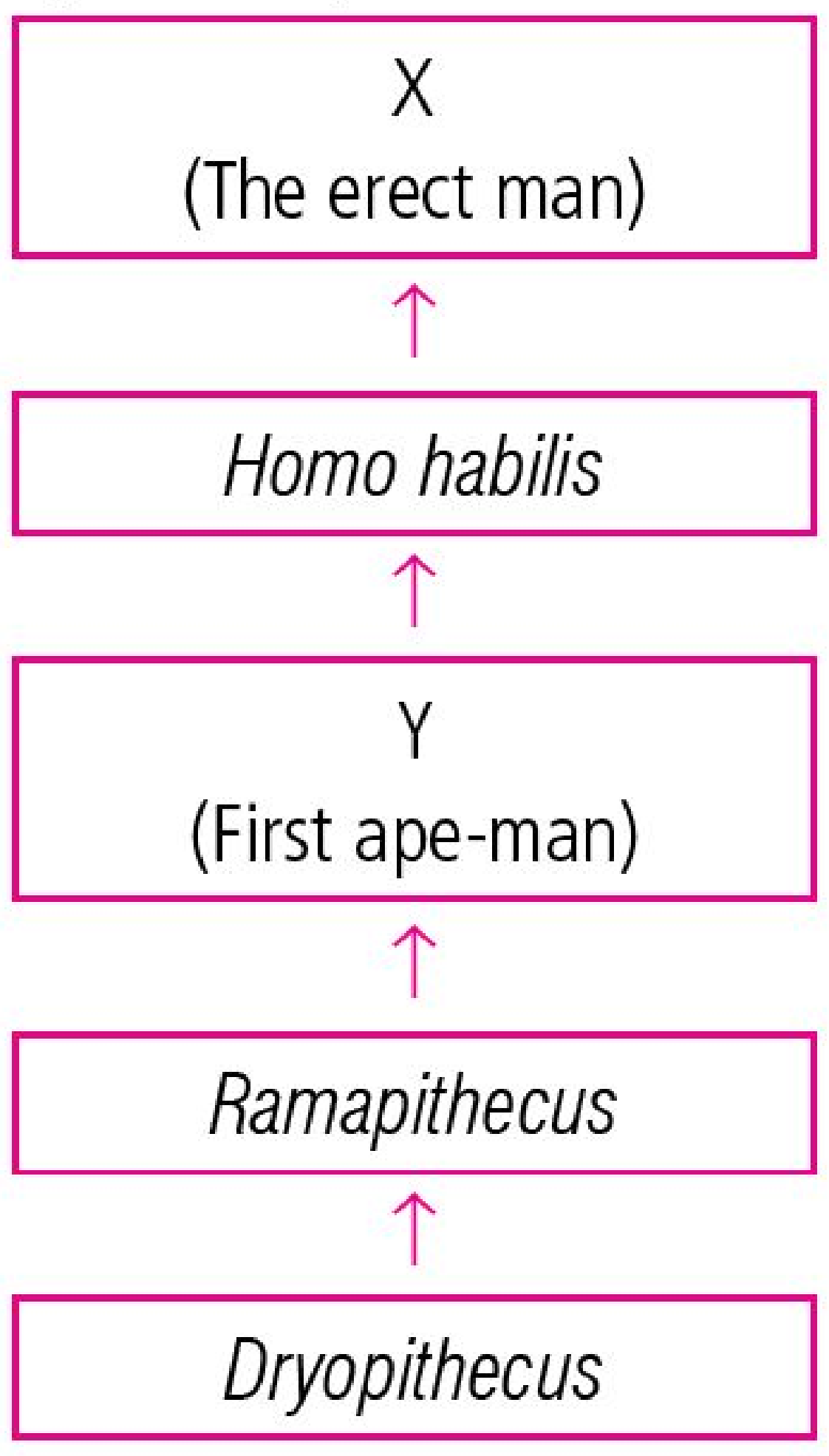
(iii) During X, the radioactive probes
(a) hybridise with DNA sample to form double stranded structure
(b) degrade the DNA
(c) create positive charge on DNA
(d) cut the DNA sample at various sites.

(iv) In India, X technique was developed by
(a) Dr. Lalji Singh (b) Alec Jeffreys
(c) Dr. Khorana (d) none of these.

(v) Which of the following is true about X?
(a) VNTR is used as probe.
(b) DNA samples are loaded on agarose gel electrophoresis.
(c) It is based on identification of nucleotide sequence present on the DNA molecule.
(d) All of these

11. Read the passage given below and answer the following questions.

Human evolution is a lengthy evolutionary process within the history of primates. The stages given here show the order of evolutionary history of man.



(i) Identify 'X' and 'Y'.
(a) X-*Homo erectus*, Y-*Australopithecus*
(b) X-*Australopithecus*, Y-*Homo erectus*
(c) X-Apes, Y-*Australopithecus*
(d) X-*Homo sapiens*, Y-Apes

(ii) The brain capacity of 'X' was about
(a) 1400cc (b) 1650cc
(c) 900cc (d) 300cc.

(iii) 'Y' arose during which epoch?
(a) Oligocene (b) Pleistocene
(c) Holocene (d) Pliocene

(iv) Select the incorrect statement regarding 'Y'.
(a) It was with bipedal locomotion.
(b) It essentially ate fruit.
(c) Its brain capacity was about 900cc.
(d) It had erect posture.

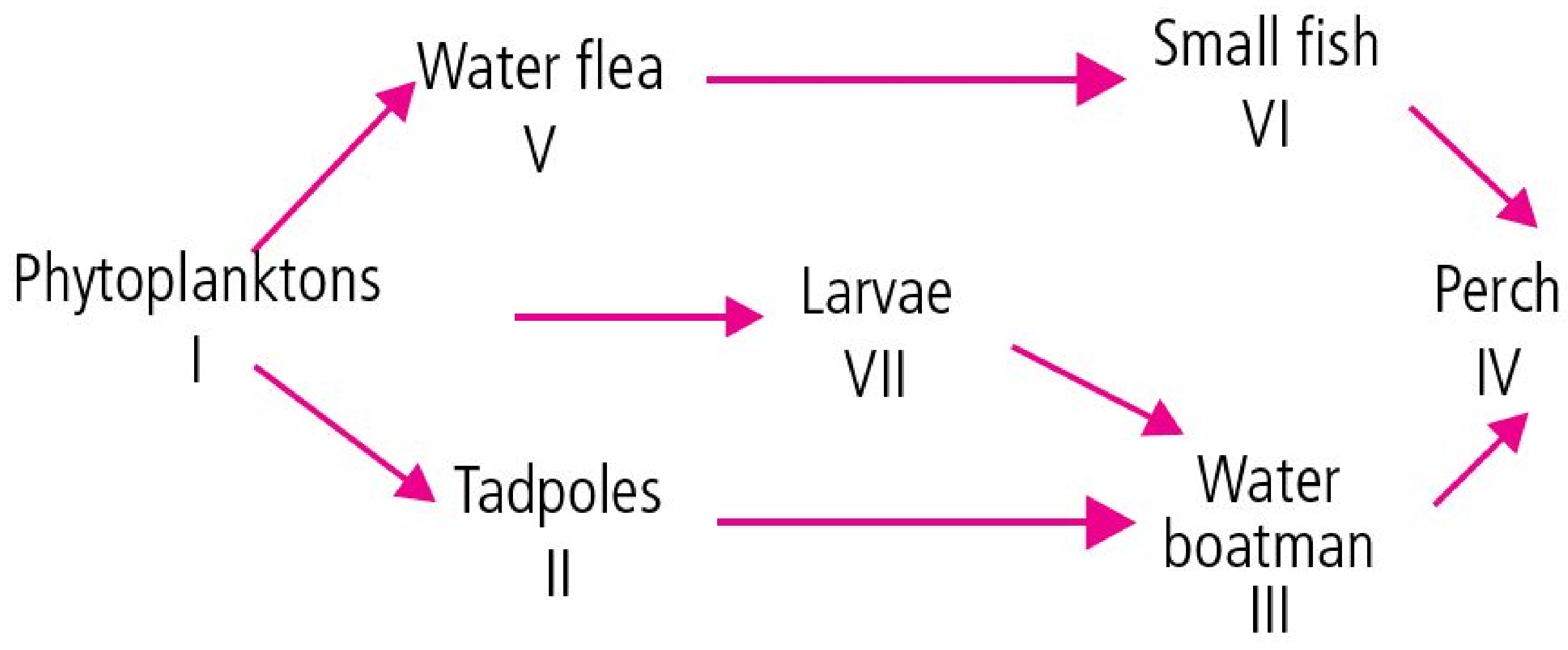
MONTHLY TEST DRIVE CLASS XII ANSWER KEY

1.	(c)	**2.**	(a)	**3.**	(b)	**4.**	(c)	**5.**	(a)
6.	(c)	**7.**	(c)	**8.**	(a)	**9.**	(b)	**10.**	(b)
11.	(a)	**12.**	(a)	**13.**	(a)	**14.**	(b)	**15.**	(d)
16.	(d)	**17.**	(c)	**18.**	(b)	**19.**	(b)	**20.**	(d)
21.	(c)	**22.**	(a)	**23.**	(d)	**24.**	(c)	**25.**	(c)
26.	(d)	**27.**	(c)	**28.**	(c)	**29.**	(d)	**30.**	(b)
31.	(a)	**32.**	(a)	**33.**	(b)	**34.**	(b)	**35.**	(c)
36.	(a)	**37.**	(b)	**38.**	(d)	**39.**	(b)	**40.**	(b)

(v) Which of the following is a fossil of 'X'?
(a) Java Ape-man (b) Peking man
(c) Heidelberg man (d) All of these

12. Read the passage given below and answer the following questions.

Food chains in natural conditions never operate as isolated sequences, but are interconnected with each other forming some sort of interlocking pattern, which is referred to as a food web. Study the given food web.



(i) Which of the following organisms in the given food web act as a secondary consumers?
(a) II and V (b) III and VI
(c) III and IV (d) V and VII

(ii) Which of the following organisms in the given food web act both as a predator and a prey?
(a) I, II and IV only (b) II, III and V only
(c) II, III, V, VI and VII only (d) II, III and VI only

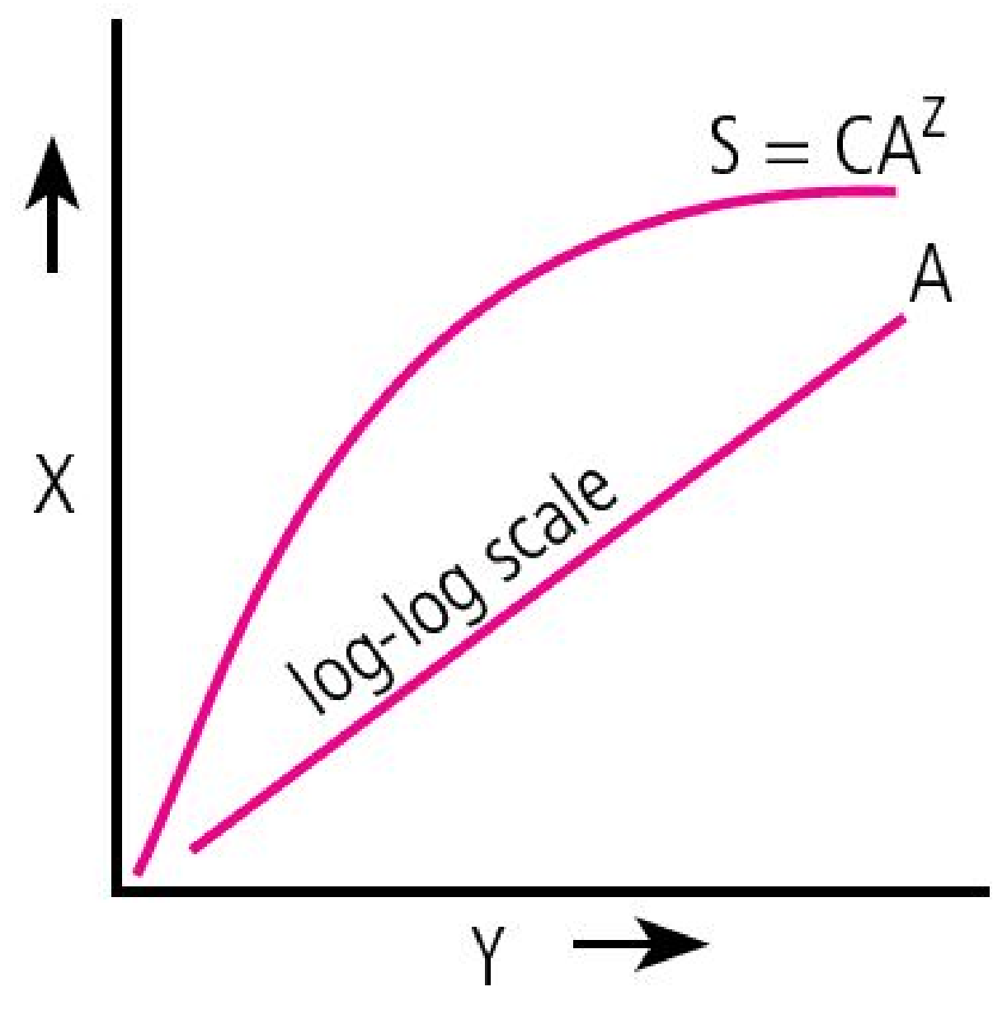
(iii) How many food chains are interconnected with each other in the given food web?
(a) 2 (b) 3
(c) 4 (d) 5

(iv) In the given food web, an increase in the population of (IV (perch) will not result in
(a) decrease in the population of III
(b) decrease in the population of VI
(c) decrease in the population of V
(d) both (a) and (b).

(v) Select the incorrect statement(s) regarding food web.
(a) Members of higher trophic level can feed upon a number of alternative organisms of lower trophic level.
(b) Presence of food webs adds to the instability of the ecosystem.
(c) They increase adaptability and competitiveness of the organisms.
(d) All of these

13. Read the passage given below and answer the following questions.

Within a region, species richness increases with increasing explored area, but only upto a limit. The given graph explains this relationship.



(i) What does the given figure show?
(a) Rivet-popper hypothesis
(b) Species-area relationship
(c) Proportionate number of species of major taxa
(d) α-ecological diversity

(ii) Equation for relationship (A) between species richness and area is
(a) $\log S = \log C + Z \log A$
(b) $\log C = \log S + Z \log A$
(c) $Z \log A = \log S + \log C$
(d) $\log S = \log C + \log A$.

(iii) What is the value of slope of line or regression coefficient Z for frugivorous birds?
(a) 0.1-0.2 (b) 1.15
(c) 0.01-0.1 (d) 0.6-1.2

(iv) The shape of curve for relationship between species richness and areas for wide variety of taxa is
(a) straight line
(b) parabola
(c) rectangular hyperbola
(d) bell shaped.

(v) Who gave this concept of increase in species richness with increasing explored area?
(a) Humboldt (b) Odum
(c) Edward Wilson (d) Paul Ehrlich

14. Read the passage given below and answer the following questions.

A group of teenagers was involved in drug abuse. They used syringes and needles to inject drugs. They indulged in this habit when they became adults. Administration of drug through needles became a piece of cake for them. Raj was the most active drug abuser amongst them and used to take drugs in high profile parties. In a span of time he started losing weight and suffered persistent diarrhoea. He developed constant low grade fever and used to catch opportunistic infection. When he consulted a doctor, he got himself tested positive for a virus in his blood and finally diagnosed with a disease 'X' that affects immune system, which may acquired during the lifetime of individual.

(i) How do you think Raj got the above mentioned infection?

(ii) How virus that infected Raj can be diagnosed?

(iii) How can transmission of the virus prevented?

OR

(iii) Discuss briefly about the structure of virus responsible for disease 'X'.

SUBJECTIVE QUESTIONS

15. (a) Can a plant flowering in Mumbai be pollinated by pollen grains of the same species growing in New Delhi? Provide explanations to your answer.

(b) Draw the diagram of a pistil where pollination has successfully occurred. Label the parts involved in reaching the male gametes to its desired destination.

16. (a) Describe the role of LH in the process of spermatogenesis.

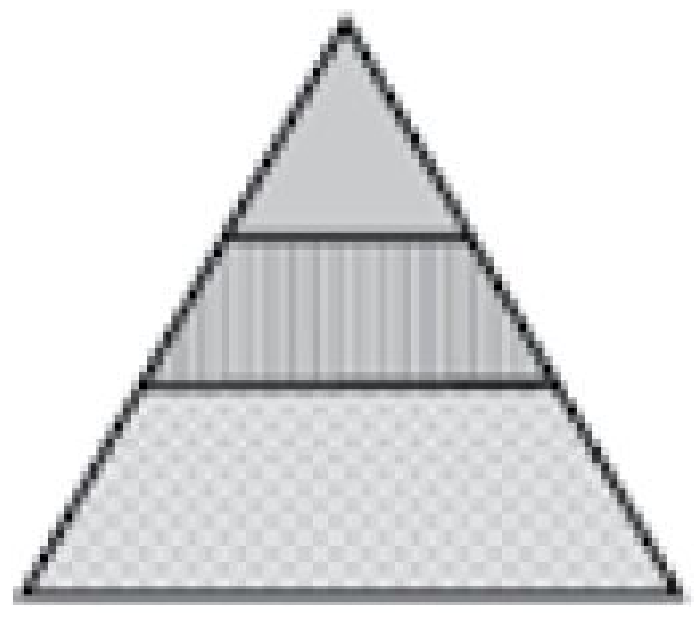
(b) Name the cells and their products which undergo:

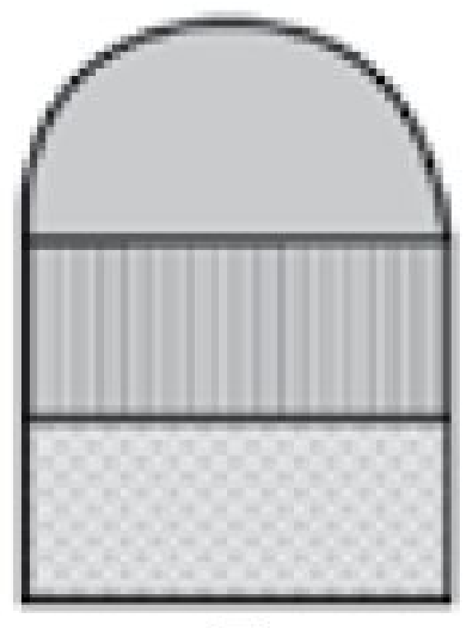
(i) Mitosis and Differentiation
(ii) Meiosis I and Meiosis II
during the process of spermatogenesis.

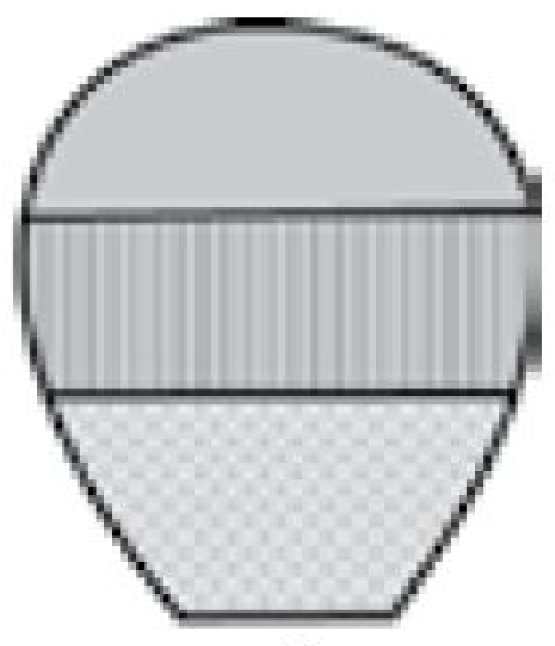
(c) Name the accessory ducts that the sperms travel through from seminiferous tubules to reach the epididymis.

17. Name the genus of baculovirus that acts as a biological control agent inspite of being a pathogen. Justify by giving three reasons that make it an excellent candidate for the job.

18. Read the passage given below and answer the following questions:
Age pyramids generally represent the structure of population of a region on the basis of age and sex. Study the given three representative figures of age pyramids relating to human population.


A


B


C

(i) What does the shape of the given age pyramids B and C denote about human population?

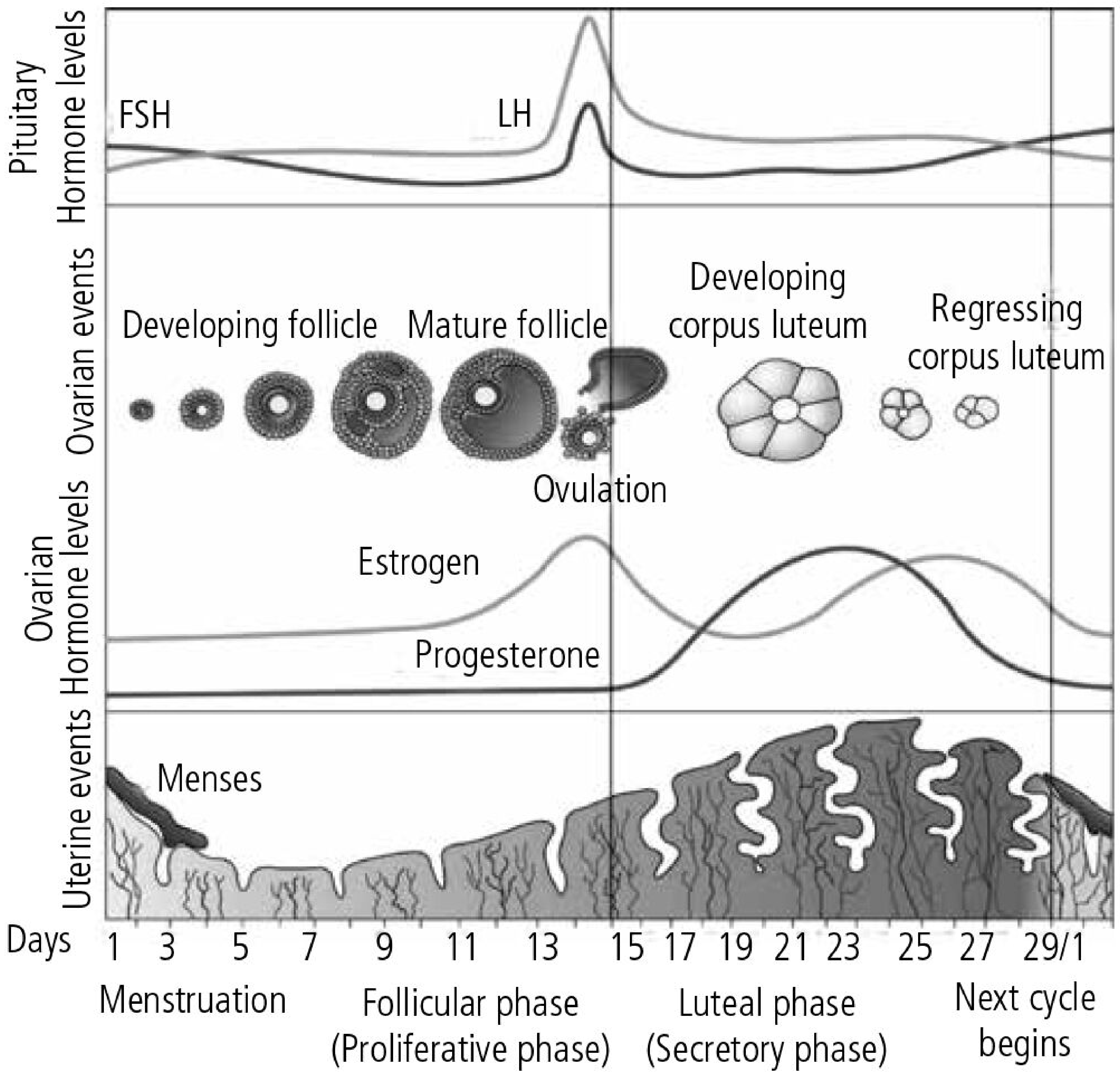
(ii) What is the significance of age pyramid?

(iii) How do the given structure of a population influences population growth?

OR

(iii) Identify 'A'. Why did you name it so?

19. In a human female, the reproductive phase starts on the onset of puberty and ceases around middle age of the female. Study the graph given below regarding menstrual cycle and answer the questions that follow:



(a) Name the hormones and their source organ, which are responsible for menstrual cycle at puberty.

(b) For successful pregnancy, at what phase of the menstrual cycle an early embryo (upto 3 blastomeres) should be implanted in the uterus (IUT) of a human female who has opted for Assisted Reproductive Technology (ART)? Support your answer with a reason.

(c) Name the hormone and its source organ responsible for the events occurring during proliferative phase of menstrual cycle. Explain the event.

OR

(c) In a normal human female, why does menstruation only occurs if the released ovum is not fertilised? Explain.

20. Read the following statement and answer the questions that follow : "A guava fruit has 200 viable seeds."

(a) What are viable seeds?

(b) Write the total number of :
(i) Pollen grains
(ii) Gametes
in producing 200 viable guava seeds.

SOLUTIONS

1. **(a)** Frequency of recessive trait (q^2) = 9% = 0.09 (Given)

$\therefore \quad q=\sqrt{0.09}=0.3$

According to Hardy-Weinberg principle,
$p^2 + 2pq + q^2 = 1$

where, p^2, q^2 and 2pq represent frequency of homozygous dominant (AA), homozygous recessive (aa) and heterozygous individuals (Aa) respectively.

$p + q = 1$ or $p = 1 - q$

$\therefore \quad p = 1 - 0.3 = 0.7,$

The frequency of homozygous dominant snakes is,
$p^2 = 0.7 \times 0.7 = 0.49 = 0.49 \times 100 = 49\%$

The expected frequency of heterozygous dominant snakes (2pq) is likely to be:
$= 2 \times 0.7 \times 0.3 = 0.42 = 0.42 \times 100 = 42\%$

(b) In the given population of snakes living in desert with brown sand, population two have evolved from population one through natural selection, *i.e.*, organisms that are best suited to their environment were able to reproduce well in changed environmental conditions. Due to colour of the sand, grey snakes stood out in contrast to its background that increases the possibility of being easily detected and eaten by their predators, such as birds, in much greater number than brown snakes. Ultimately, there is decrease in the number of grey snakes and increase in the number of brown snakes in the population.

2. **(i)** The three parameters of male fertility which get affected due to cryptorchidism are as follows:

1. Sperm count decreases, spermatogenesis is impaired.
2. Spermatids do not get nourishment to develop into spermatozoa thus spermiogenesis will be affected.
3. Leydig cells synthesise and secrete androgen hormones (like testosterone) so secretion of androgens will be affected.

(ii) Spermiation

(iii) There are two techniques in which sperm/semen is used to assist fertilisation which are as follows:

1. Artificial insemination (AI) technique, in this technique the semen collected either from the husband or a healthy donor is artificially introduced either into the vagina or into the uterus (IUI – intra – uterine insemination) of the female.
2. Intra cytoplasmic sperm injection (ICSI) is another specialised procedure to form an embryo in the laboratory in which a sperm is directly injected into the ovum.

(iv) The zygote or early embryos (with upto 8 blastomeres) could be transferred into the fallopian tube (ZIFT–zygote intra fallopian transfer). Embryos with more than 8 blastomeres are transferred into the uterus (IUT – intra uterine transfer), to complete its further development.

3. **(i) (b) :** A – Secondary effluent, B – River water, C – Primary effluent, D – Untreated sewage water.

Sample 'C' is primary effluent because it is formed after the primary treatment where the solids are settled to form sludge. Therefore, some amount of BOD be reduced in sample 'C'.

(ii) **(b)**

(iii) **(d) :** A number of pathogenic microbes are mostly present in sewage water. They are removed during secondary or biological treatment. During primary treatment, small and large, floating and suspended solids are removed through filtration and sedimentation.

(iv) **(a) :** Biochemical oxygen demand is a measure of the organic matter present in the water.

(v) **(b) :** The water released after sewage treatment is released in river water. Therefore, the river water will be identified as the lowest BOD level *i.e.*, 5 mg/L.

4. **(i)** The diagram shows life cycle of *Plasmodium. Plasmodium* enters the human body (Y) as sporozoites through the bite of infected female *Anopheles* mosquito (X).

(ii) The parasite reproduces asexually in liver cells, bursting the cell and releasing into the blood.

(iii) Parasites reproduce asexually in red blood cells thereby bursting the RBCs and causing cycles of fever, chills and other symptoms. Released parasites infect new red blood cells.

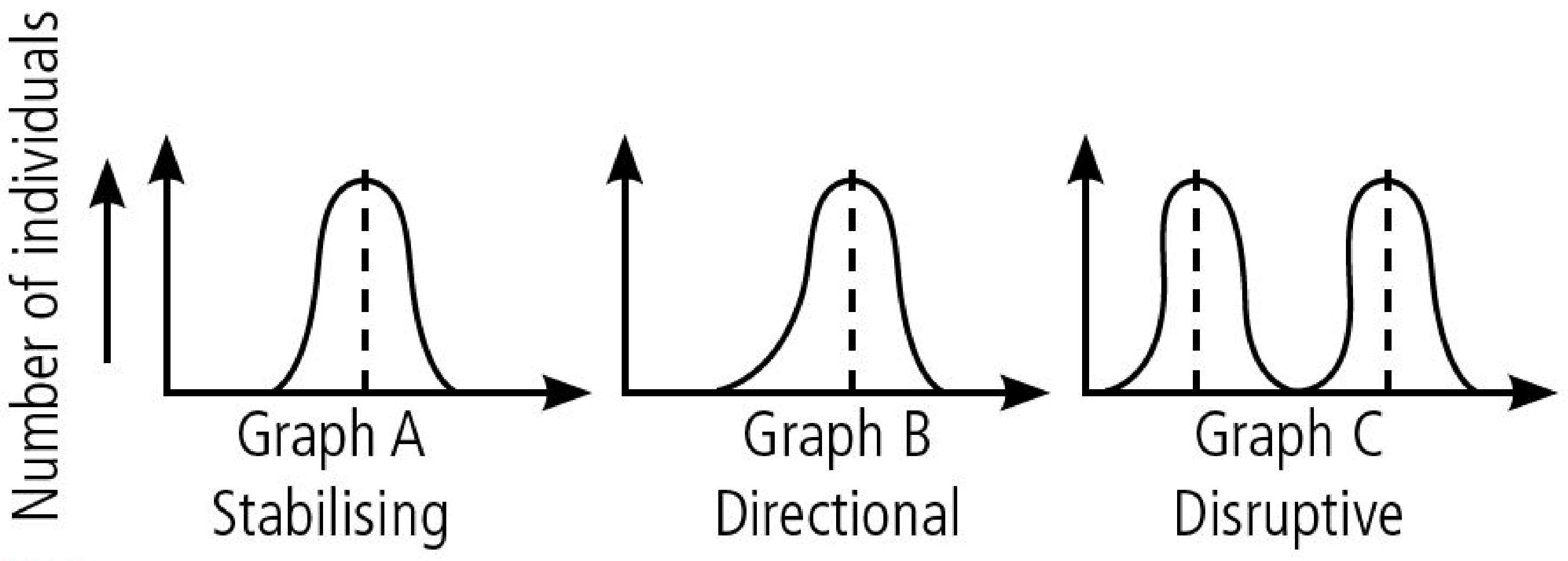
(iv) When a female *Anopheles* mosquito (*X*) bites an infected person (*Y*), these parasites enter the mosquito's body as gametocytes where they undergo fertilisation and further development. The parasites multiply within them to form sporozoites that are stored in salivary glands of mosquito.

OR

(iv) Humans (*Y*) experience the symptoms of disease when parasite ruptures the red blood cells causing chills and fever. The disease is malaria. The rupture of RBCs is associated with release of a toxic substance, haemozoin, which is responsible for the chill and high fever recurring every three to four days.

5. **(a)** A -stabilising; B - directional; C - disruptive

(b) After the selection has operated for several generations in the given populations represented by graph A, B and C are graphically illustrated as follows:



6. **(a)** The colonies of plate I do not produce any colour as β-galactosidase enzyme is responsible for blue colour. Gene is inserted in the β-galactosidase site of the plasmid, thereby causing insertional inactivation of the enzyme, so no blue colour appears.

(b) Plate II produces blue coloured colonies as gene of interest has not been inserted in the plasmid and Plate III also produces blue coloured colonies as no plasmid is inserted in the bacteria.

7. **(i)** Since X cells have unlimited capability and can differentiate into both embryonic and extraembryonic tissues, they belong to the category of totipotent stem cells. These cells are present in the earliest stages of development, such as in a fertilised egg (zygote) and early embryonic cells. They have the potential to form an entire organism, including the placenta and other supporting tissues necessary for fetal development.

(ii) Z cells are multipotent and can only differentiate into specific cell types. They are not capable of forming all types of tissues in the body but are restricted to certain cell lineages, such as blood cells. They are expected to give rise to platelets, erythrocytes and white blood cells.

(iii) Pluripotent stem cells (Y cells) are crucial in therapy because they can generate various specialized cells that help in tissue regeneration. They can be used to repair damaged tissues, such as in heart disease or spinal cord injuries. Scientists can use them to create disease models for research and drug testing. Pluripotent stem cells play a pivotal role in advancing medical science and regenerative medicine.

OR

(iii) Y is pluripotent stem cell. Pluripotent stem cells have the ability to give rise to most, but not all, tissues of an organism. Unlike totipotent cells, they cannot form extraembryonic tissues such as the placenta. These cells are found in the inner cell mass (ICM) of a blastocyst and can differentiate into various cell types that make up the body. During gastrulation, the ICM differentiates into the three primary germ layers.

8. **(a)** In this ecosystem, a single tree supports multiple herbivores birds, which in turn nourish a large number of parasites and hyperparasites. Since the number of organisms increases at each successive trophic level, it results in an inverted pyramid of numbers, which is a characteristic feature of parasitic food chains.

(b) If a predator for zooplankton is introduced in the pond ecosystem, the biomass pyramid will undergo significant changes. Initially, the pond follows an inverted pyramid of biomass, where predator significantly reduces the zooplankton population, the biomass at this level will decreases. Phytoplankton will increase due to less consumption pressure, forming a broader base. Small fishes may decrease due to reduced food availability. The ecosystem will initially show a spindle shaped biomass pyramid.

(c) The ecosystem Z always has an upright pyramid. This is because the number of producers are highest and the number of organisms gradually decreased at each successive trophic level in Z ecosystem.

OR

(c) Although the shape of pyramids varies across different ecosystems in terms of numbers and biomass, one common feature among all three ecosystems is that they always have an upright energy pyramid. This is because energy is lost at each trophic level due to respiration, heat dissipation, and metabolic activities. Therefore, the energy flow remains unidirectional and follows a consistent decreasing trend across all ecosystems, making the pyramid of energy always upright in X, Y, and Z.

9. **(a)** The inability of bacterial colony 4 to grow on plate N indicates that its tetracycline resistance gene has become non-functional due to the insertion of the foreign gene. Bacteria that lost tetracycline resistance due to foreign gene insertion will be sensitive to tetracycline and will not grow on plate N.

(b) Colonies 1,2,3 and 5 are non-transformants as these are present on both M and N plate. It indicates that their antibiotics genes are intact, indicating no foreign gene is inserted.

(c) Replica plating is used in bacterial transformation experiments to identify transformed bacteria and non-transformed bacteria. It involves transferring bacterial colonies onto different plates with selective media. By comparing growth patterns, scientists can determine whether a bacterium has retained or lost an antibiotic resistance gene. This allows for accurate selection of bacteria containing the recombinant plasmid.

(d) When foreign gene is inserted somewhere else instead of restriction site in plasmid, then selection of recombinants and non-recombinants would not be possible.

BIO THINK

Readers can send their responses at ***editor@mtg.in*** *or post us with complete address by 10th of every month. Winners' name and answers will be published in next issue.*

Across

Fill the grid with terms related to given images.

Down

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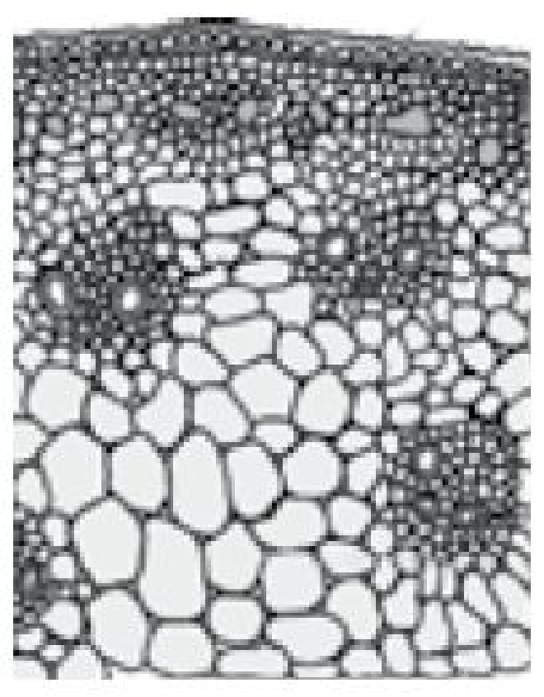

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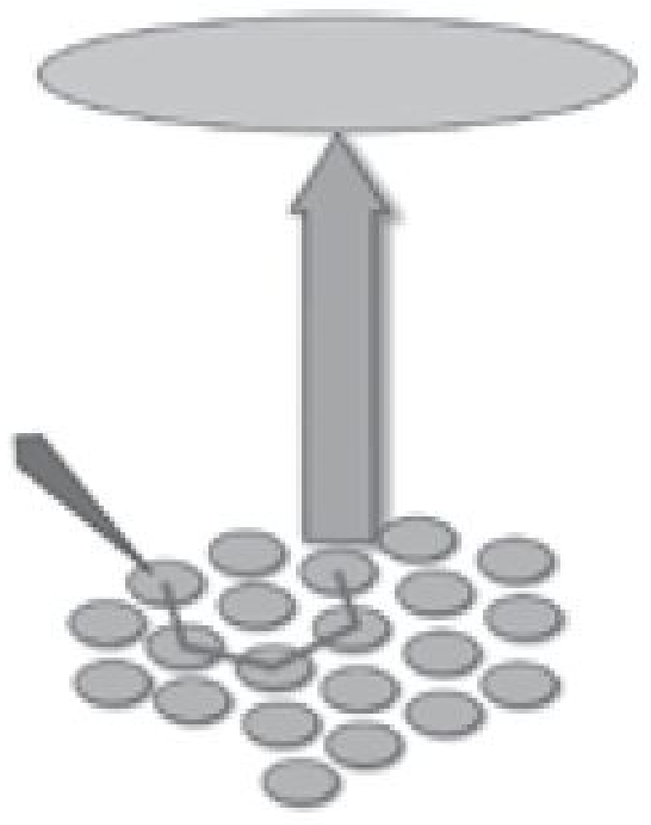

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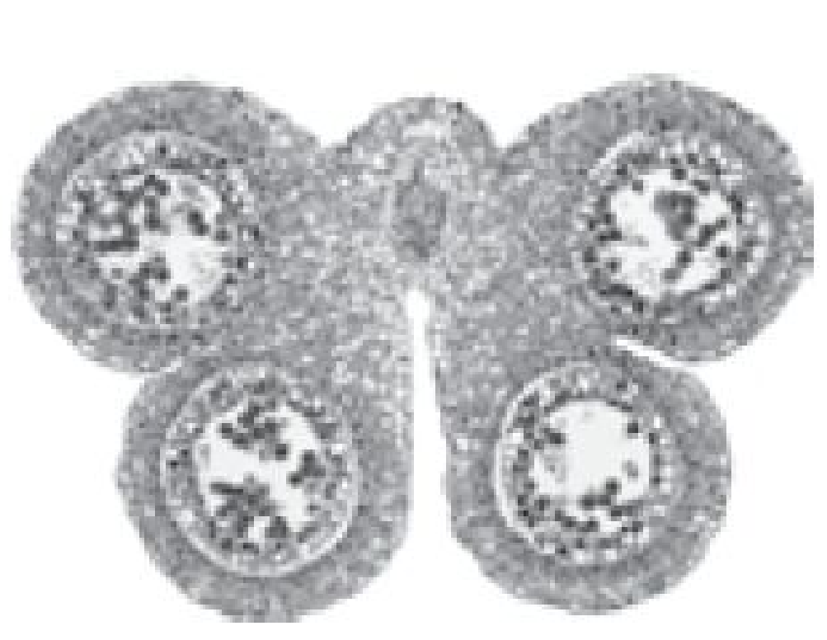

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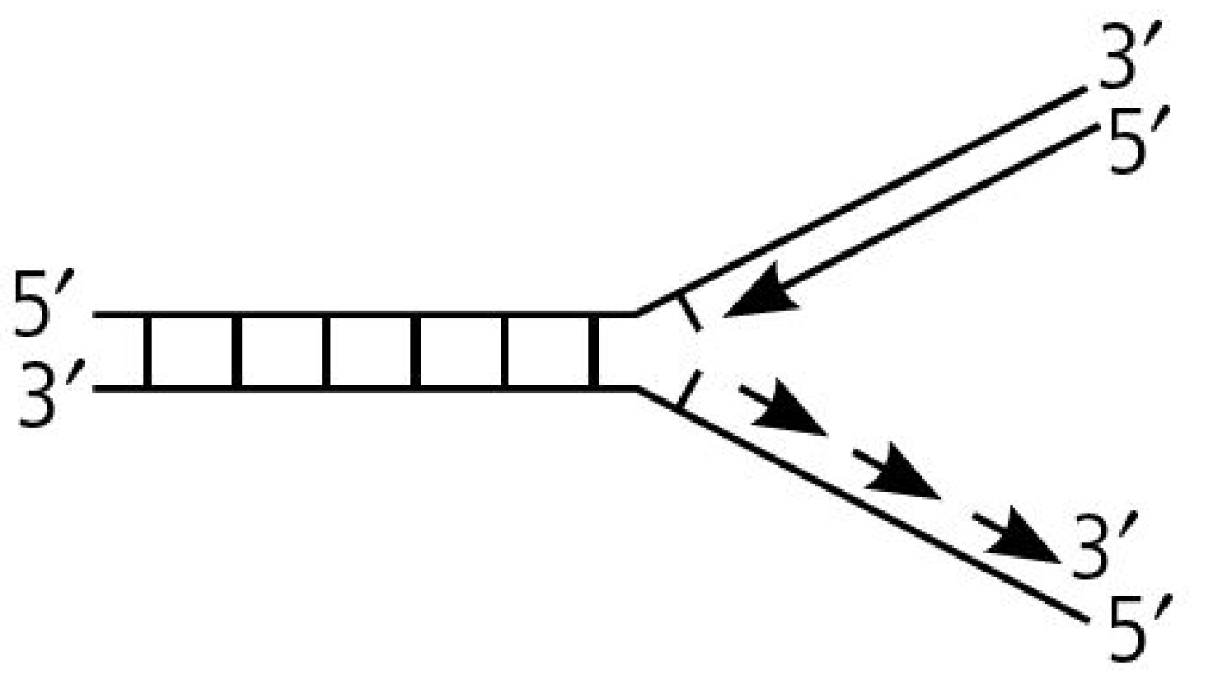

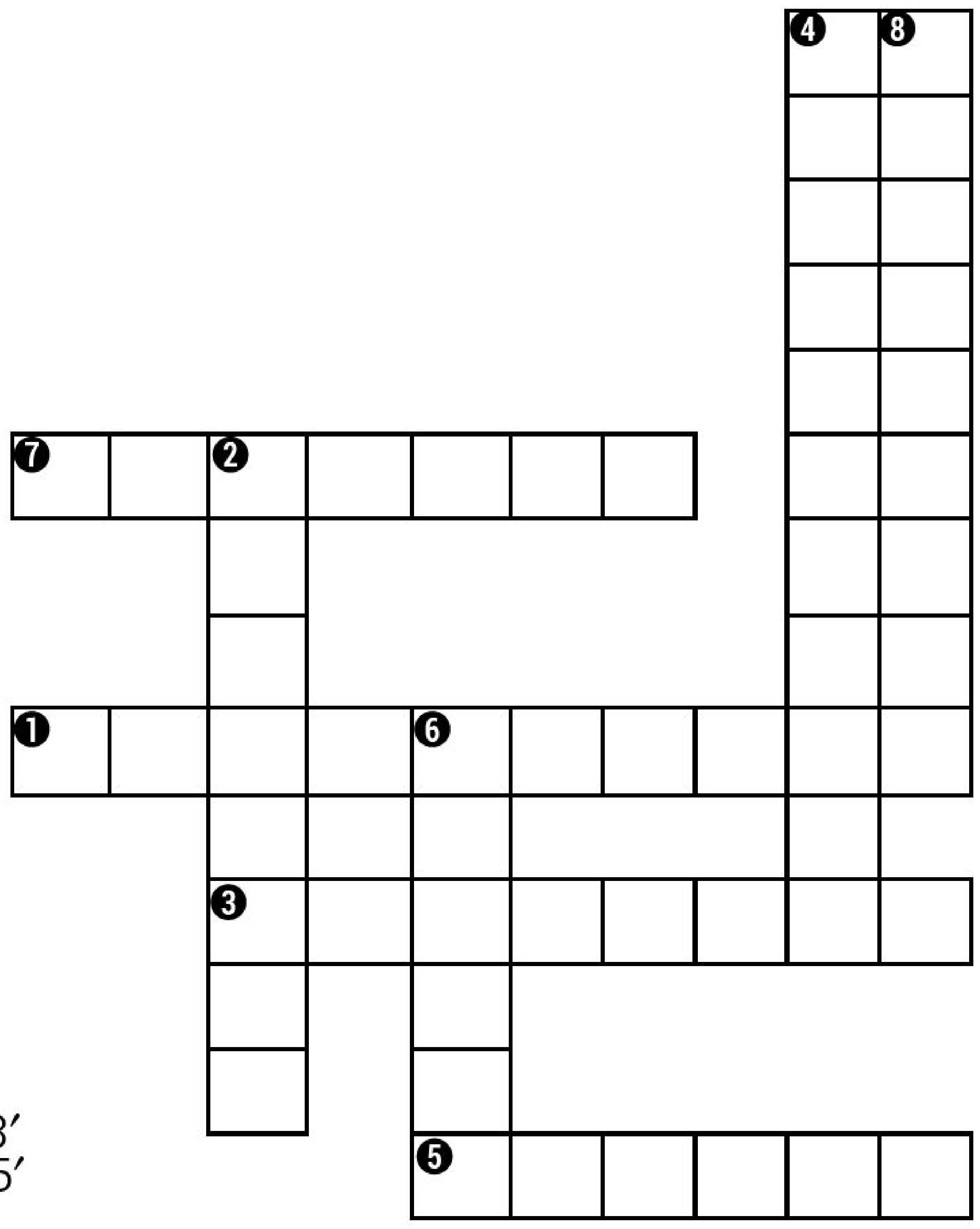

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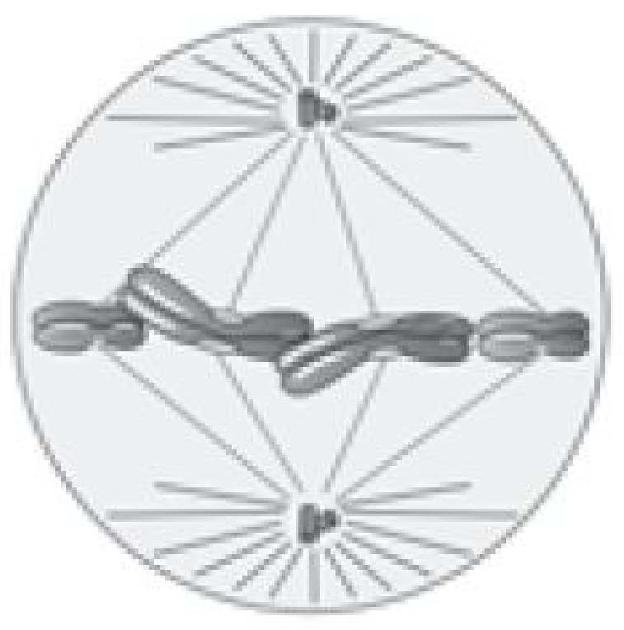

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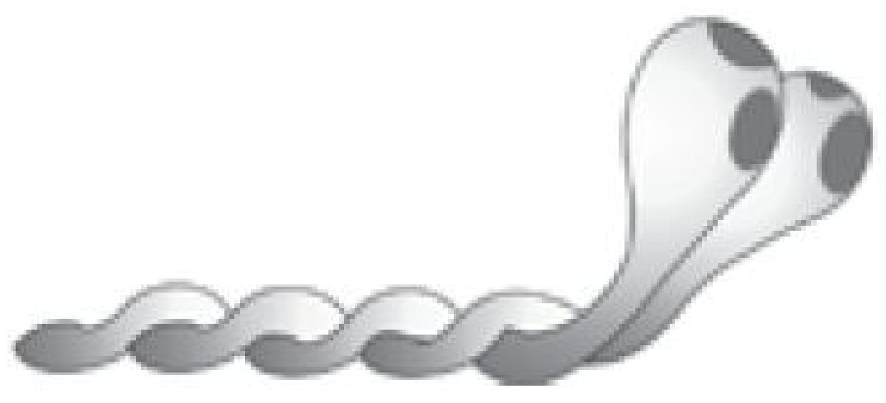

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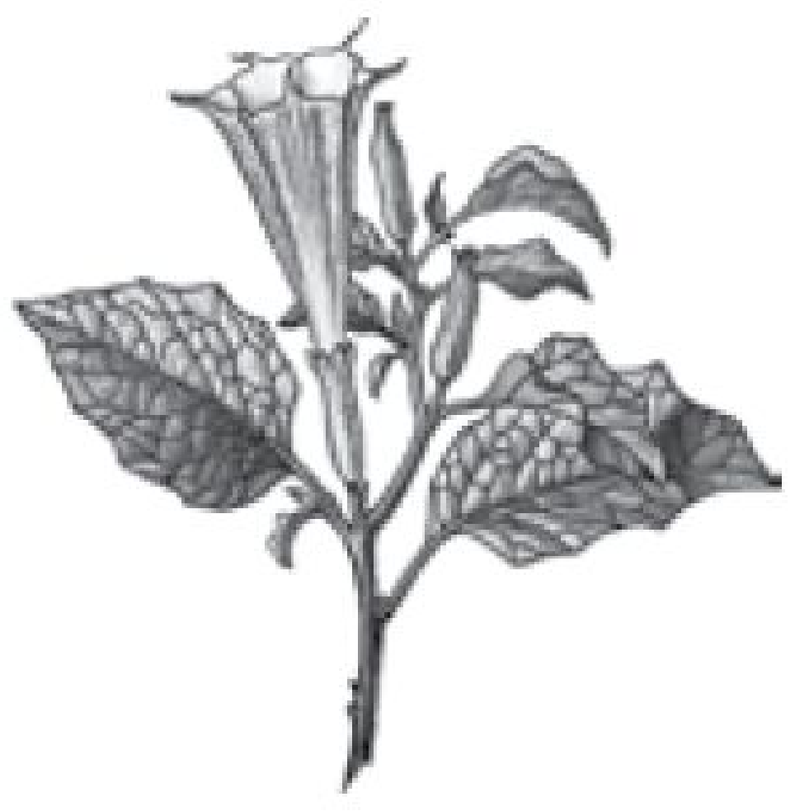

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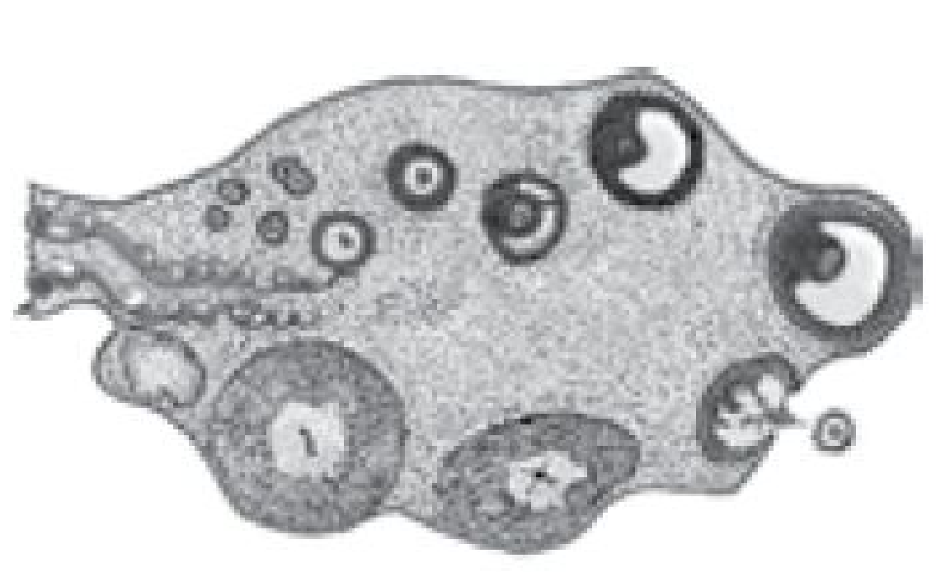


10. (i) (d) : DNA fingerprinting is a technique in which an individual's DNA is analysed to reveal the pattern of repetition of certain short nucleotide repeats called VNTRs through probe.

(ii) (d) : For DNA fingerprinting, DNA is obtained from blood, semen, hair roots, tissue samples, nuclei of white blood cells or of spermatozoa, body secretions, etc.

(iii) (a) : In DNA fingerprinting, during hybridisation the bands are flooded with single stranded radioactive DNA probe. This single stranded DNA probe and sample DNA hybridise to form double stranded structure due to natural affinity.

(iv) (a) : In India, DNA fingerprinting technique was developed by Dr. Lalji Singh.

(v) (d)

11. (i) (a) : In this representation of evolution of man, X and Y represent *Homo erectus* and *Australopithecus*, respectively.

(ii) (c) : The brain capacity of *Homo erectus* (X) was about 900cc.

(iii) (d) : *Australopithecus* arose during pliocene.

(iv) (c) : *Australopithecus* (Y) was with bipedal locomotion, ate fruit and had erect posture. It had human-like teeth. Its brain capacity was about 450cc.

(v) (d) : *Homo erectus* (X) includes three fossils : Java Ape-man, Peking man and Heidelberg man.

12. (i) (b) : In the given food web, organisms I (phytoplanktons) act as producers; organisms II, V and VII act as primary consumers as they feed on producers; organisms III and VI act as secondary consumers as they feed upon primary consumers; and organism IV acts as a tertiary consumer.

(ii) (c)

(iii) (b)

(iv) (c) : In the given food web, Perch (IV) is the top carnivore feeding upon III and VI. So, if the population of Perch would increase, they would feed more on (III) and (VI) which will result in decrease of their population. Due to less number of predators (small fish), population of water flea (V) will increase.

(v) (b) : Food webs increases the stability of the ecosystem.

13. (i) (b) : The given graph shows species-area relationship.

(ii) (a) : On a logarithmic scale, the relationship between species richness and area is a straight line.

(iii) (b) : The regression coefficient Z have a value of 1.15 for frugivorous birds and mammals of tropical forests of different continents.

(iv) (c) : The relation between species richness and area for a wide variety of taxa (angiosperm plants, birds, bats, freshwater fishes) turns out to be a rectangular hyperbola.

(v) (a) : While exploring the wilderness of South American jungles, Alexander von Humboldt found that within a region, the species richness increased with increasing area but upto a certain limit.

14. (i) Raj was a drug abuser, he might got infected by using contaminated needles and syringes to inject drugs.

(ii) ELISA test, also called EIA for enzyme immunoassay is used to detect HIV antibody. It checks for certain proteins that the body makes in response to HIV.

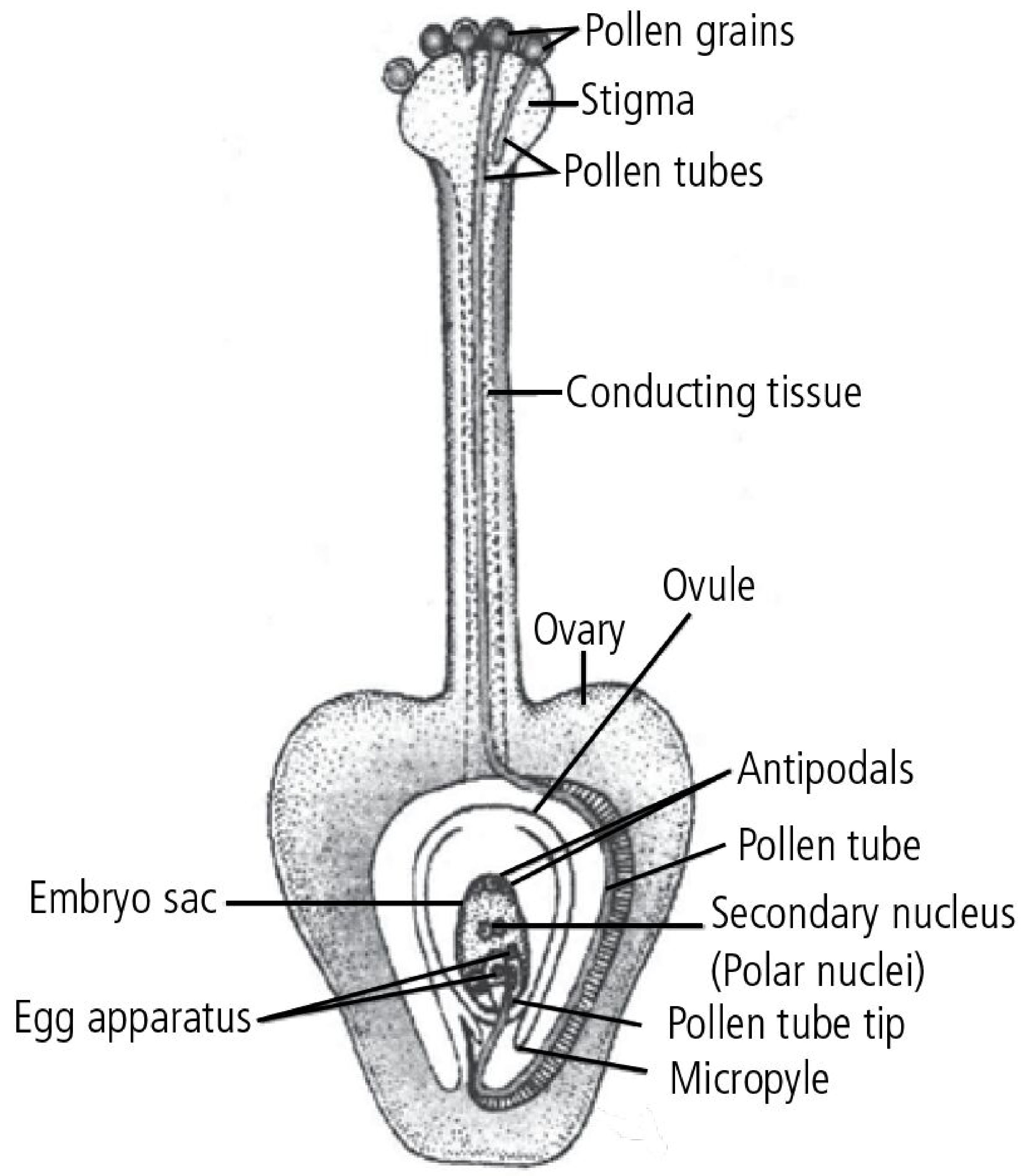
(iii) Disease 'X' is AIDS. It can be prevented by keeping blood (from blood banks) safe from HIV, ensuring the use of only disposable needles and syringes in public and private hospitals and clinics, free distribution of condoms, controlling drug abuse, advocating safe sex and promoting regular check-ups for HIV in susceptible populations.

OR

(iii) Disease 'X' is AIDS. It is caused by HIV. HIV is spherical with a diameter of 90-120 nm. Its genome consists of single stranded RNA. The envelope consists of a lipid bilayer derived from host cell membrane and projection knob like glycoproteins. It contains two protein coats.

15. (a) Yes, a plant flowering in Mumbai can be pollinated by pollen grains of the same species of flower growing in New Delhi. This can be done by preserving the pollen grains and bringing them from New Delhi to Mumbai. Now, with the help of artificial hybridisation techniques, the pollen grains are dusted over the pistil to complete the process of pollination.

(b) Longitudinal section of pistil showing the parts involved in reaching the male gamete to desired destination are shown below as :



16. (a) LH acts at the Leydig's cells and stimulates synthesis and secretion of androgens. Androgens in turn, stimulate the process of spermatogenesis.

(b) (i) Spermatogonium undergo mitotic division to produce a large number of spermatogonia, some of which actively grows to a larger primary spermatocyte. Spermatids undergo differentiation to produce spermatozoa.

(ii) A primary spermatocyte undergoes meiosis I leading to the formation of two equal, haploid cells called secondary spermatocytes.

The secondary spermatocyte undergoes meiosis II to produce four equal, haploid spermatids.

(c) The accessory ducts that the sperms travel through from seminiferous tubules to reach the epididymis are rete testis and vasa efferentia.

17. *Nucleopolyhedrovirus*, a genus of baculovirus that act as a biological control agent inspite of being a pathogen.

(i) They are species specific.

(ii) They are narrow spectrum bioinsecticides.

(iii) There is no side effect on plants, mammals, birds/ fish and non-target insects. Beneficial insects are conserved.

18. (i) The given age pyramids B and C respectively are showing bell-shaped age pyramid representing stable population and urn-shaped age pyramid representing declining population.

(ii) Age pyramids are graphic representation of different age groups found in population with pre-reproductive group at base, reproductive in middle and post-reproductive groups at top. It helps to visualise the age group of a population. The shape of the pyramids reflects the growth status of population: (a) whether it is growing, (b) stable or (c) declining.

(iii) Different age groups have different reproductive capabilities. Pre-reproductive individuals are the young individuals which will enter the reproductive age after some time. They are the potential source of increase in population. Reproductive individuals are the ones which are actually adding new members to the population. Post-reproductive individuals are older individuals which no longer take part in reproduction.

OR

(iii) 'A' is an expanding age-pyramid. The number of individuals in the pre-reproductive age group is more than that in the reproductive age group. Hence, the population is growing or expanding here.

19. (a) The hormones and their source organ responsible for menstrual cycle at puberty are as follows:

(i) Follicle stimulating hormone (FSH) is secreted by the anterior lobe of pituitary gland.

(ii) Luteinising hormone (LH) is secreted by the anterior lobe of pituitary gland.

(iii) Estrogen is secreted by ovaries, specifically by the growing ovarian follicles.

(iv) Progesterone is primarily secreted by ovaries, specifically by the corpus luteum.

(b) For successful pregnancy through assisted reproductive technology (ART) such as intra uterine transfer (IUT), the early embryo should be implanted in the uterus during the luteal phase of the menstrual cycle. During this phase, the corpus luteum secretes large amount of progesterone which is essential for the maintenance of endometrium. Gradually, this endometrium becomes thickened, providing an optimal environment for embryo implantation and its subsequent development.

(c) Hormone responsible for the events occurring during the proliferative phase are gonadotropins (LH and FSH) secreted by the anterior lobe of pituitary gland and estrogen secreted by growing follicles in the ovaries. During the proliferative phase, the primary follicles in the ovary grow to become a fully mature Graafian follicle and simultaneously the endometrium of uterus regenerates through proliferation. The levels of LH and FSH increases gradually and stimulates the ovarian follicles to secrete estrogen.

OR

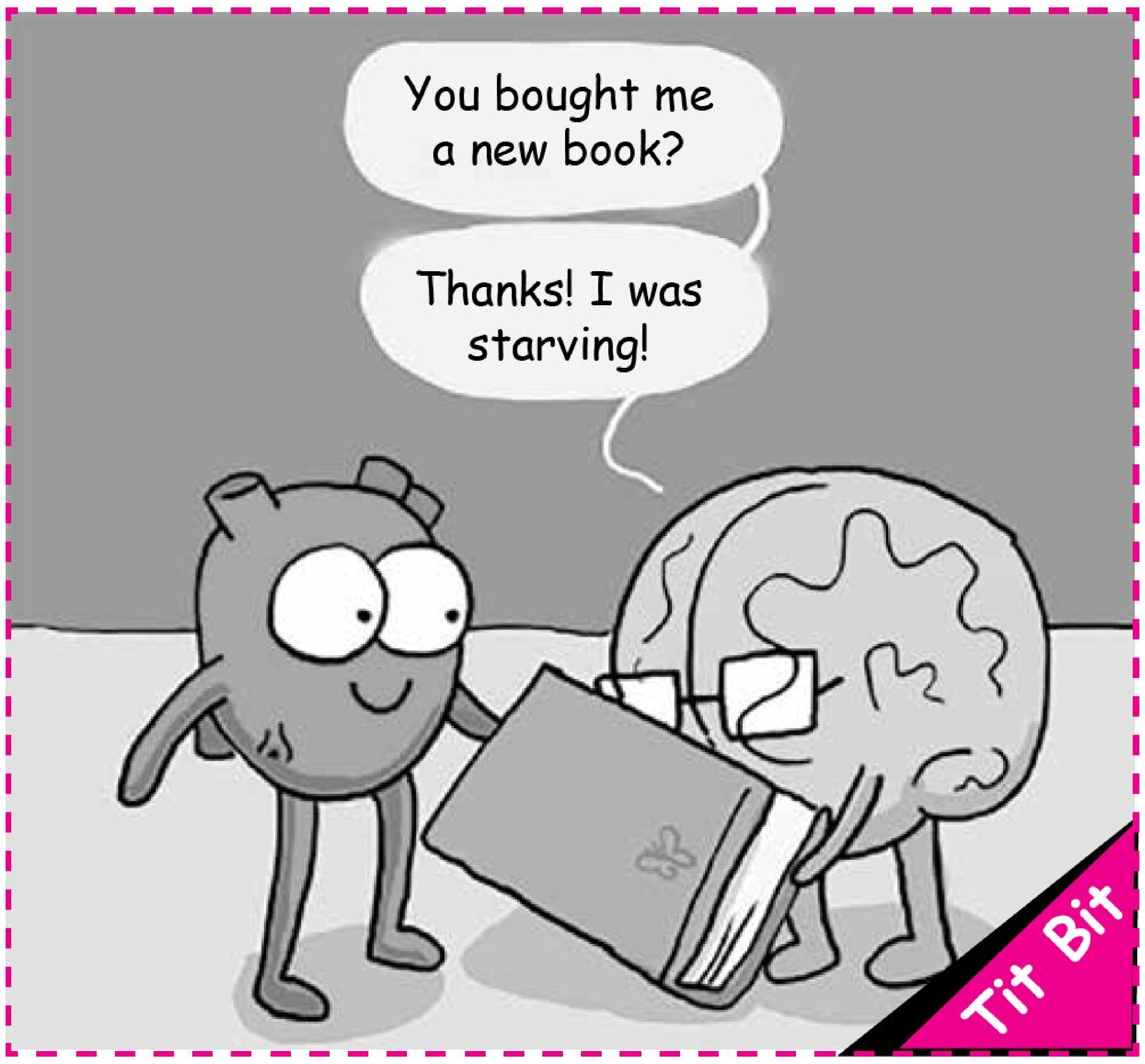
(c) In the absence of fertilisation, corpus luteum degenerates due to which the level of progesterone hormone decreases. This causes disintegration of endometrium leading to menstruation, marking a new cycle. Thus, in a normal human female, menstruation only occurs if the released ovum is not fertilised.

20. (a) : Seeds those have the ability to retain power of germination over a period of time and are capable to germinate under favourable conditions are called viable seeds.

(b) (i) 200 pollen grains are required to form 200 seeds because each pollen grain carries two male gametes but only one fuses with the egg to form a zygote that develops into a mature embryo.

(ii) Total of 600 gametes (400 male gametes + 200 female gametes) are required in prodSSucing 200 viable guava seeds.

☺☺


You bought me a new book?
Thanks! I was starving!
Tit Bit

Quiz CLUB

Unlock Your Knowledge!

1. Which of the following is defined by Mayr in 1964 as a group of potentially interbreeding populations?
(a) Genus (b) Species
(c) Variety (d) Family

2. Which of the following structures help in mutual clinging of bacteria?
(a) Rhizoids (b) Fimbriae
(c) Mesosomes (d) Hold fast

3. Which of the following is the oldest drug used for malaria?
(a) Haematin (b) Schuffner's dots
(c) Quinine (d) Haemotoxin

4. Which of the following scientist synthesised human insulin for the first time?
(a) Sanger (b) Saran
(c) Tsan (d) Leonard

5. Which reaction occurs during peptide and glycosidic bond formation?
(a) Esterification (b) Hydration
(c) Dehydration (d) Acidification

6. Which of the following is represents heart murmur?
(a) Lubb (b) Lubb shhh
(c) Dub (d) Dub shhh

7. Which of the following known as false labor?
(a) Passage of food through alimentary canal
(b) Peristaltic movements
(c) Braxton Hick's contraction
(d) Lactation

8. Which of the following is a device to prevent self pollination?
(a) Geitonogamy (b) Karyogamy
(c) Autogamy (d) Herkogamy

9. An acellular layer in an antral follicle
(a) granulosa (b) theca interna
(c) stroma (d) zona pellucida.

10. Bengal Tiger belongs to which category?
(a) Pandemic (b) Endemic
(c) Alien (d) Extinct

11. Deficiency of which of the following causes Alzheimer?
(a) Dopamine (b) Glutamic acid
(c) GAEA (d) Acetylcholine

12. How many triplet codons out of all 64 codons show all the three bases identical?
(a) 12 (b) 8
(c) 6 (d) 4

13. Identify connective link between reptiles and birds.
(a) Mole (b) Eel
(c) *Archaeopteryx* (d) Shrews

14. Which of the following was the first artificial cloning vector?
(a) pBR322 (b) *Thermus aquaticus*
(c) *Agrobacterium* (d) Retrovirus

15. On which day International Tiger Day is celebrated?
(a) 24 July (b) 13 July
(c) 29 July (d) 11 July

Answer Key

☺☺
1. (b) **2.** (b) **3.** (c) **4.** (c) **5.** (c)
6. (b) **7.** (c) **8.** (d) **9.** (d) **10.** (b)
11. (d) **12.** (d) **13.** (c) **14.** (a) **15.** (c)

WHO AM I ...

1.	Nodes	Pg. 11
2.	Perianth	Pg. 14
3.	Sclereid	Pg. 19
4.	Mesophyll cells	Pg. 20
5.	Reverse transcriptase	Pg. 62
6.	Allolactose	Pg. 66

Class XI

ZOOM in BIO

The syllabus of biology for boards and competitive exams is very vast which impedes students from acquiring indepth knowledge and covering the entire syllabus at the same time. An important topic for biology is therefore presented here in elaborate form to enable students grasp the topic.

Cell : The Unit of Life

All living organisms we observe around ranging from microscopic organisms *e.g.*, bacteria to giant organisms like elephant are made up of cells. The cells are capable of independent existence and carrying out all essential functions of life. Thus, cell forms the basic structural and functional unit of life.

CELL THEORY

The cell theory was put forward jointly by **Schleiden** and **Schwann**. It was later modified by Rudolf Virchow, which gave cell theory its final shape. The main postulates of cell theory are:

- All living organisms are composed of cells and their products.
- Cells form the unit of both structure and function in living beings.
- New cells develop from pre-existing cells.

Characteristics of cell

Every cell is capable of forming the whole individual. This potential of forming the whole individual is called **totipotency**.

Differential expression of genes and hence specialisation of cells is meant for increasing efficiency and division of labour. Thus, different cells have taken over different structural and functional activities.

Cells show wide variations in their sizes, shape and activities, such as they show variations in shape ranging from disc like (RBCs), polygonal (cells of cortex), columnar (epithelial cells), cuboidal, amoeboid (WBCs), thread like or irregular cells.

Life of every organism, whether unicellular or multicellular begins as a single cell. All the cells of the body are derived from the single cell or **zygote.**

Besides performing a special function for the body, each and every cell carries out all the life processes in its cytoplasm and various organelles.

Important discoveries related to cell

Scientist	Discovery
Robert Hooke	The cell in sections of cork.
Robert Brown	Presence of **nucleus** in the cells of orchid root.
Schleiden	Plant cells have similar structure, the cell wall, a clear jelly-like substance and a nucleus.
Schwann	Discovered that animal cells lack cell wall.
Purkinje and Von Mohl	Renamed sarcode or the jelly like substance of the cells as **protoplasm**.
Rudolf Virchow	Gave the theory '*omnis cellula e cellula*'- means new cells develop by division of the pre-existing cell.
Ernst Haeckel	Introduced term **plastid** and established that nucleus stores and transmits hereditary traits.

Surface: Volume Ratio

The limit of cell size or volume is determined by factors such as:

- Nucleocytoplasmic ratio
- Ratio of surface area to volume of cell.
- Ability of oxygen and other materials to reach every part of cell.
- Ability of waste products to be passed outside.
- Rate of metabolic activity.

Significance of surface: volume ratio

- Surface volume ratio decreases with increase in cell size.
- Metabolically active cells are smaller due to higher nucleocytoplasmic ratio and higher surface volume ratio. Since larger nucleus have better control of metabolic activities while cytoplasm will allow faster exchange of materials between cell and environment.
- Larger cells have lesser surface volume ratio and therefore are less efficient. Such cells are mostly inactive.

Prokaryotic cell

- Cell is usually small (0.1-2.0 μm).
- Cell is bounded by a cell wall, which possess muramic acid.
- An organised nucleus is absent, instead a nucleoid is found.
- DNA is naked, that is, without an association with histones. DNA is usually circular.
- The amount of DNA remains the same throughout the life cycle.
- Transcription and translation occur in the cytoplasm.
- Cell organelles like ER, mitochondria, Golgi apparatus, lysosomes and centrioles (centrosome, central apparatus) are absent.
- Ribosomes are of 70S type.

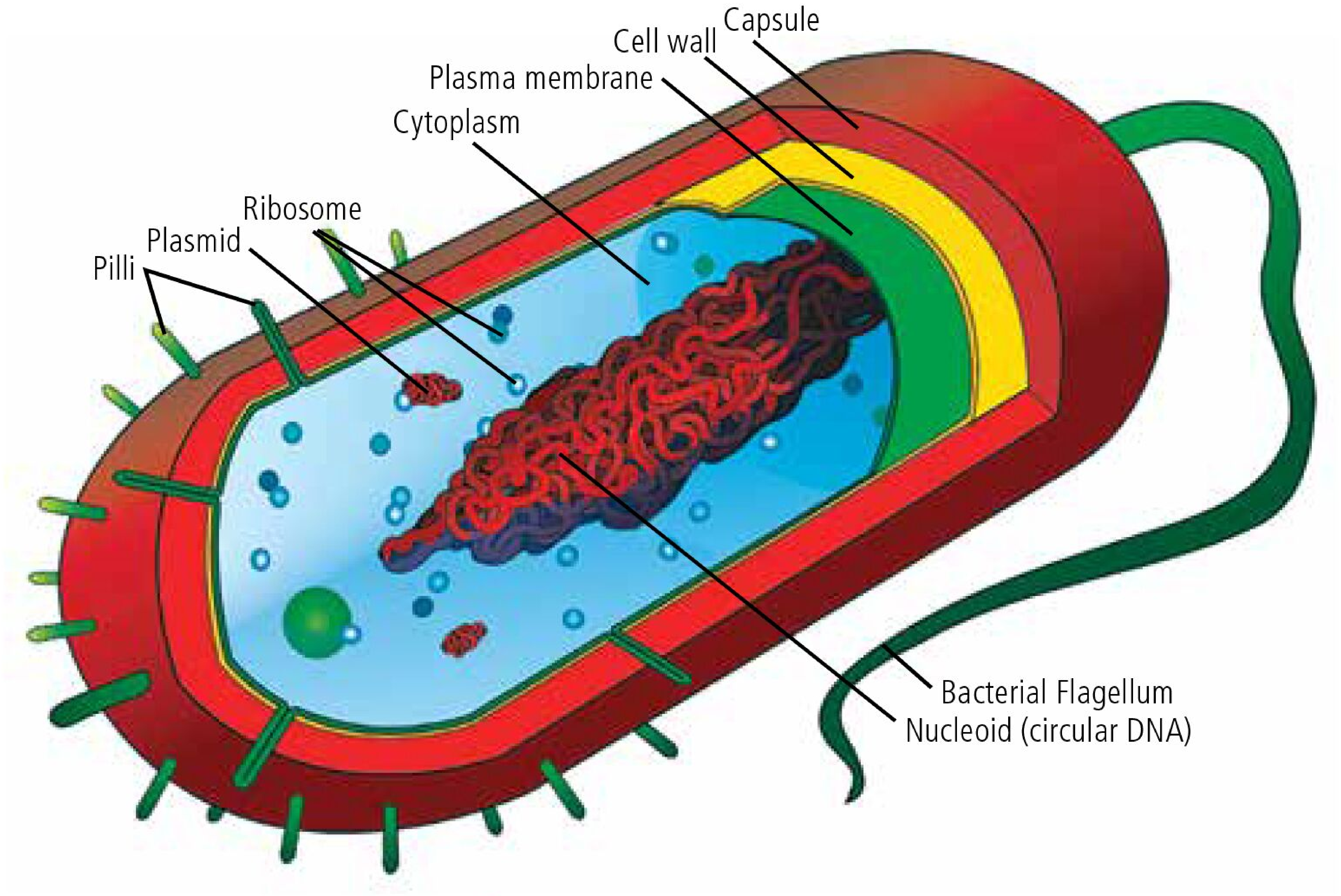


Fig.: Prokaryotic Cell : Bacteria

Eukaryotic cell

- The cell is comparatively larger (10-100 μm).
- Cell may or may not possess cell wall. Animal cells lack cell wall while those of plants and fungi have cell wall. Muramic acid is absent.
- An organised nucleus is found. It is differentiated into nuclear envelope, chromatin, one or more nucleoli, and nucleoplasm.
- Nuclear DNA is associated with histone proteins. Nuclear DNA is linear while extra-nuclear DNA is circular.
- The amount of DNA shows a regular alternation between diploid and haploid stages.
- Transcription occurs in the nucleus while translation takes place in the cytoplasm.
- ER, mitochondria, Golgi apparatus and lysosomes or their equivalents are present in all the eukaryotic cells. Centrioles are usually present in animal cells.
- Ribosomes are of 80S type.

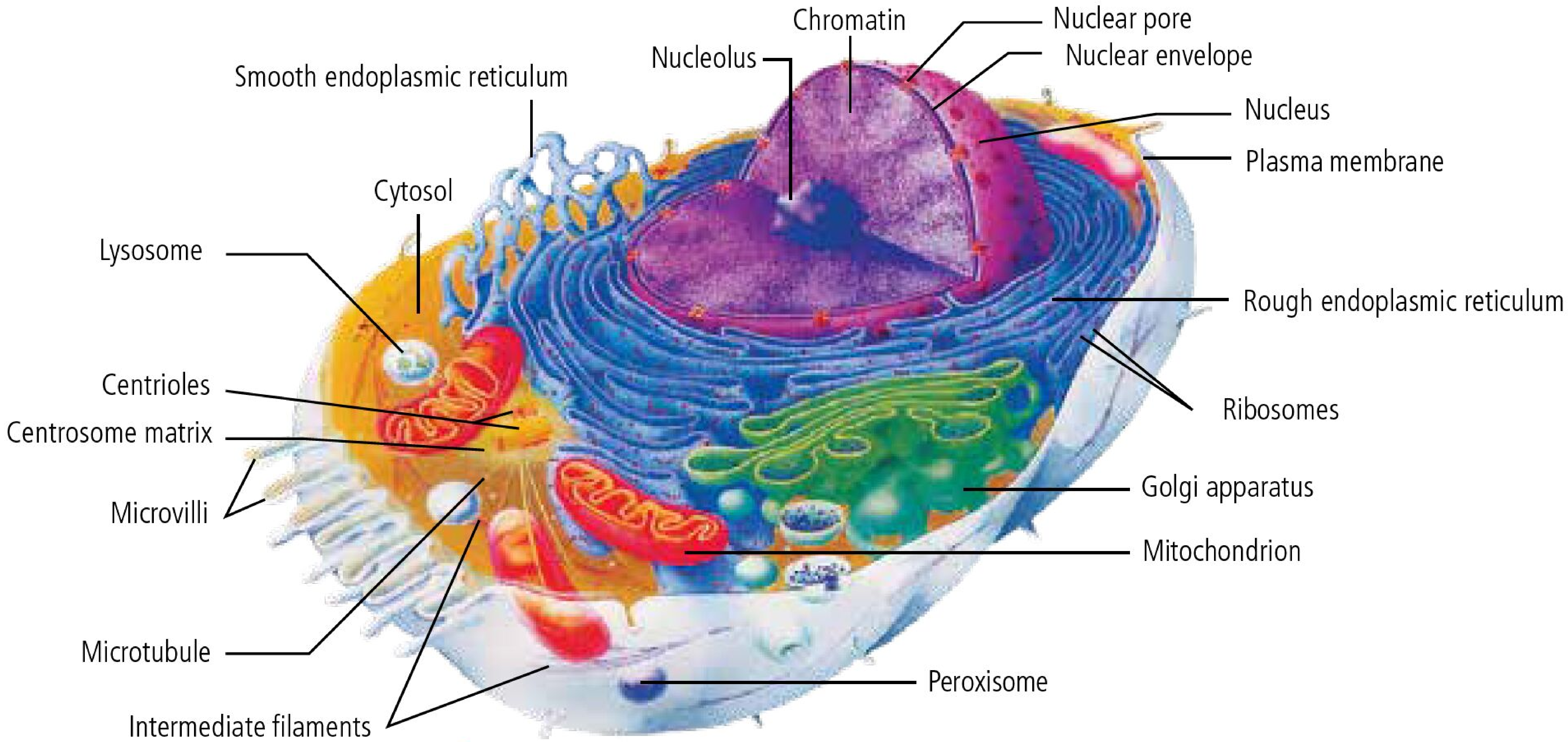

Chromatin
Nuclear pore
Nuclear envelope
Nucleolus
Smooth endoplasmic reticulum
Nucleus
Plasma membrane
Cytosol
Lysosome
Rough endoplasmic reticulum
Ribosomes
Centrioles
Centrosome matrix
Golgi apparatus
Microvilli
Mitochondrion
Microtubule
Peroxisome
Intermediate filaments

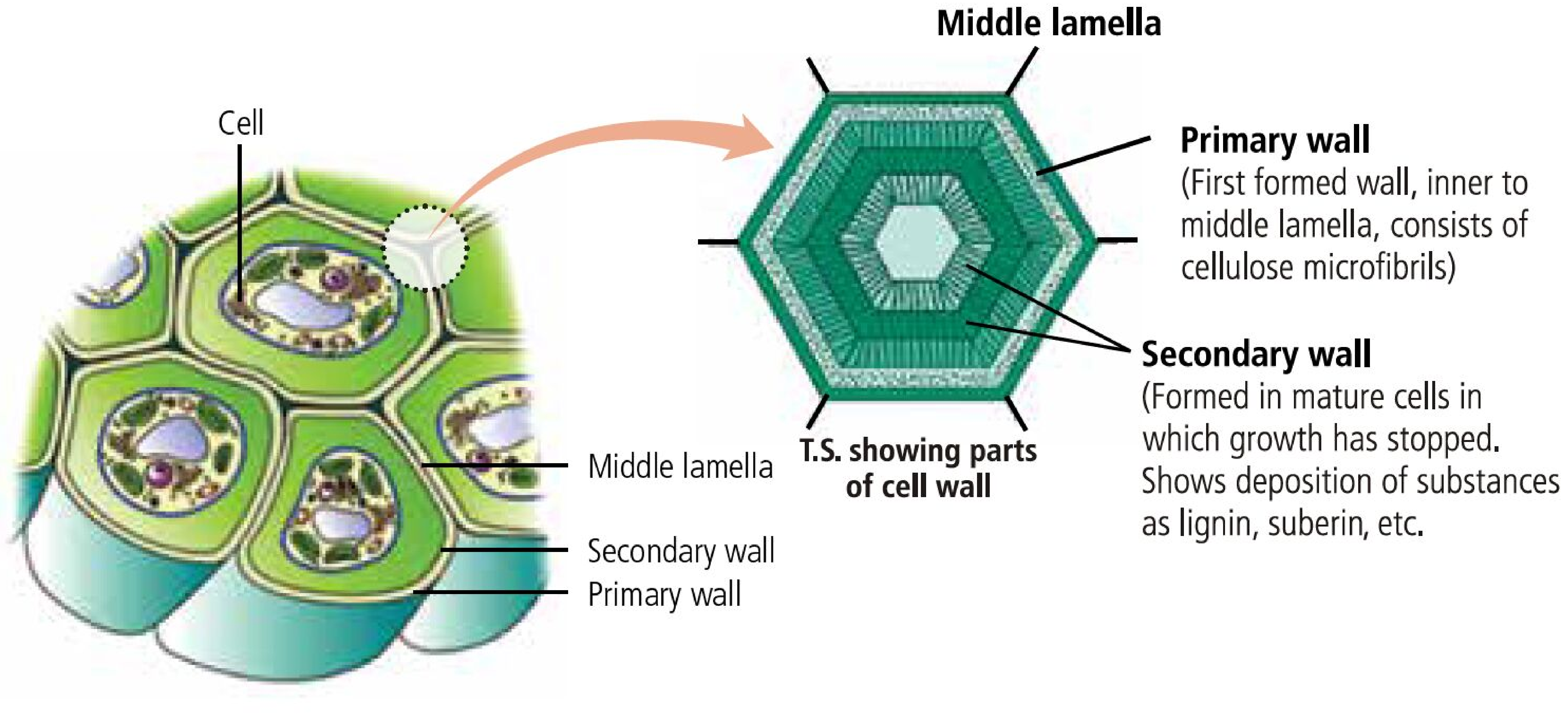
Fig.: Ultrastructure of an Animal Cell

STRUCTURE OF EUKARYOTIC CELL

A cell in general comprises of following main components:

Cell Wall

It is the outer rigid, protective, a semitransparent covering of plant cells, fungi and some protists. The cell wall of algae have alginic acid while cell wall of fungi have glucosamine and chitin. The plant cell wall is composed of a variety of polysaccharides, lipids, proteins and mineral deposits like silicates and carbonates of calcium and magnesium.


Middle lamella
Cell
Primary wall
(First formed wall, inner to middle lamella, consists of cellulose microfibrils)
Secondary wall
(Formed in mature cells in which growth has stopped. Shows deposition of substances as lignin, suberin, etc.
T.S. showing parts of cell wall
Middle lamella
Secondary wall
Primary wall

Functions	Provides shape and rigidity to cell.	Protects protoplasm from mechanical injury.	Counteracts osmotic pressure and prevents bursting of plant cells by inhibiting excessive endosmosis.

CONCEPT

MAP

Morphology of Flowering Plants

Plant morphology (Gk. morphe-form, logos-study) deals with the study of forms and features of different plant organs like roots, stems, leaves, flowers, fruits, seeds, etc. The angiosperms or flowering plants show a large diversity in external structure or morphology, but they are all characterised by presence of roots, stems, leaves, flowers and fruits. The underground part of the flowering plant is the root system while the portion above the ground forms the shoot system.

Types of Leaf

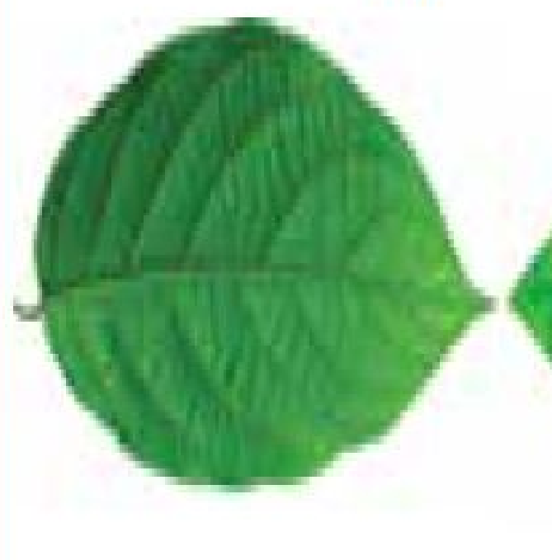
Pinnately compound leaf *e.g.,* Neem

Palmately compound leaf *e.g.,* Silk cotton

Leaf Modifications

- Support : tendril *e.g.,* Pea
- Protection: spines *e.g., Cactus*
- Storage : fleshy leaves *e.g., Onion*

Types of Venation


Reticulate venation

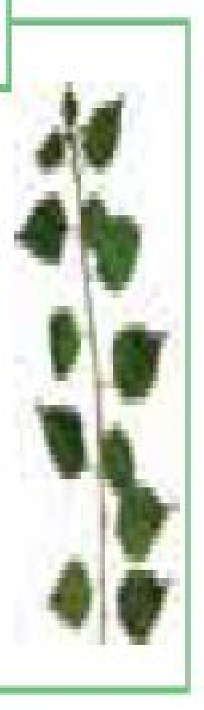
Parallel venation

Phyllotaxy

Arrangement of leaves on the stem or branch

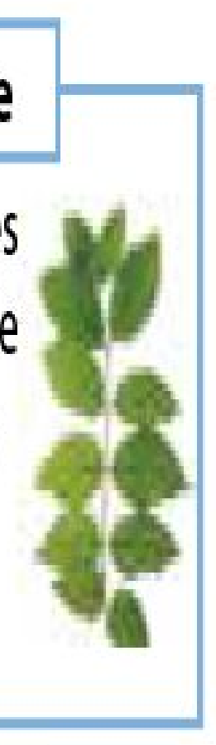
Alternate

A single leaf arises at each node in alternate manner, *e.g.,* China rose.



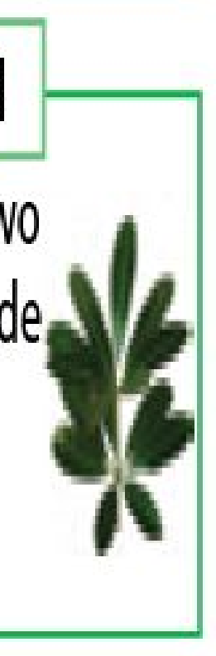
Opposite

A pair of leaves arise at each node on opposite sides, *e.g., Calotropis,* guava.



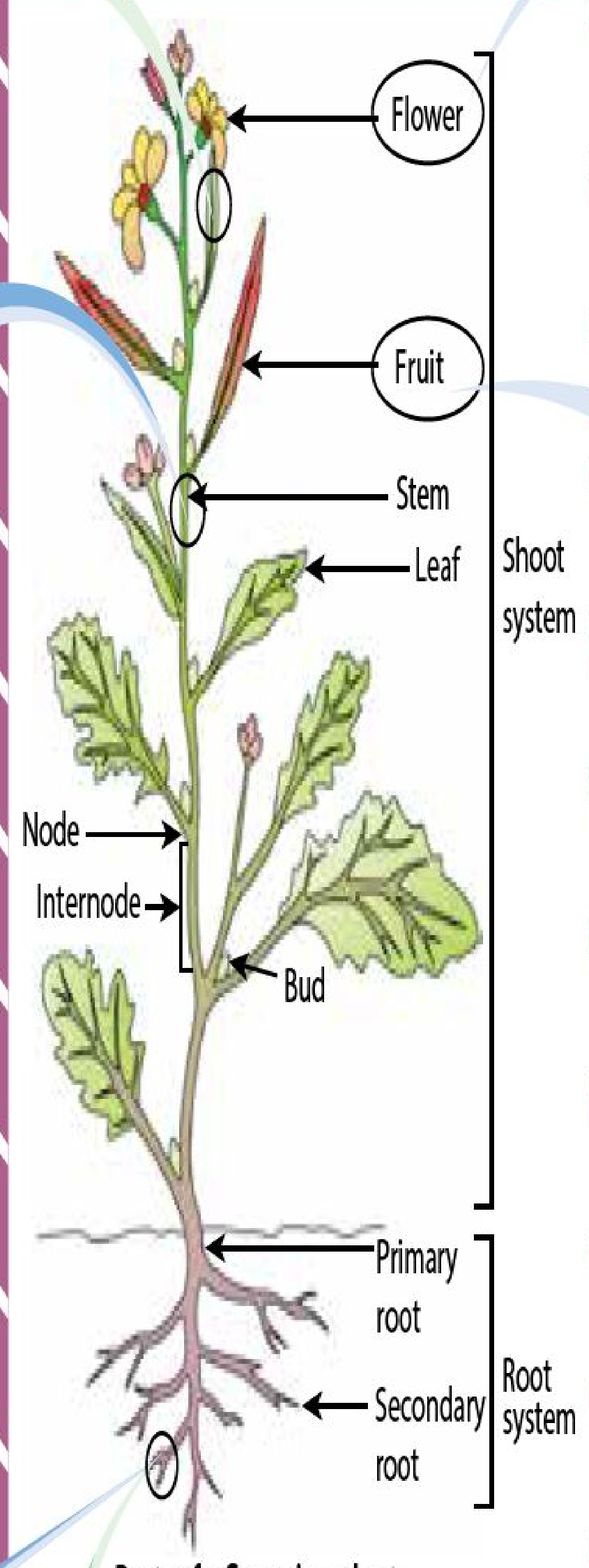
Whorled

More than two leaves arise at a node and form a whorl, *e.g., Alstonia.*



Stem Modifications

- Undergound
  - Rhizome *e.g.,* Ginger
  - Corm *e.g., Colocasia*
  - Bulb
    - Imbricate *e.g., Lilium*
    - Tunicate *e.g., Allium*
  - Tuber *e.g., Solanum*
- Aerial
  - Thorn *e.g., Citrus*
  - Tendrils *e.g.,* Gourds
  - Phylloclade *e.g., Opuntia*
  - Cladode *e.g., Asparagus*
  - Bulbil *e.g., Agave*
- Sub-aerial
  - Runner *e.g., Cynodon*
  - Sucker *e.g., Mentha*
  - Offset *e.g., Pistia*
  - Stolon *e.g., Rubus*

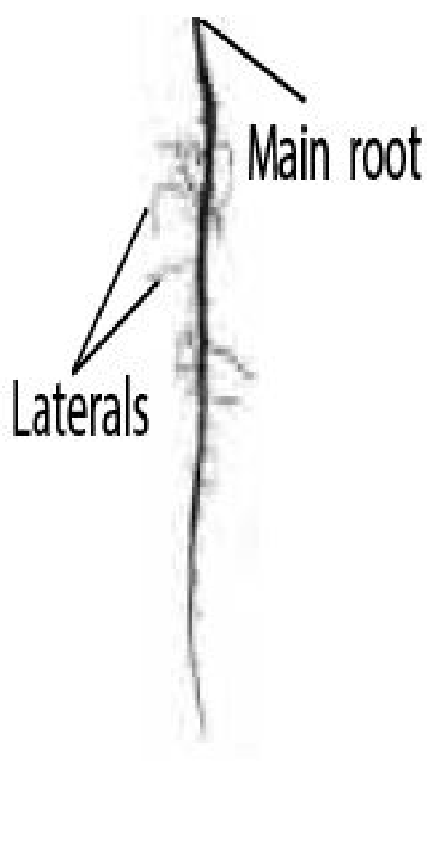

Flower
Fruit
Stem
Leaf
Shoot system
Node
Internode
Bud
Primary root
Secondary root
Root system

Parts of a flowering plant

Different Types of Roots

Taproot system

E.g., Dicots (Mustard)


Main root
Laterals

Fibrous root system

E.g., Monocots (Wheat)

Fibrous roots

Adventitious root

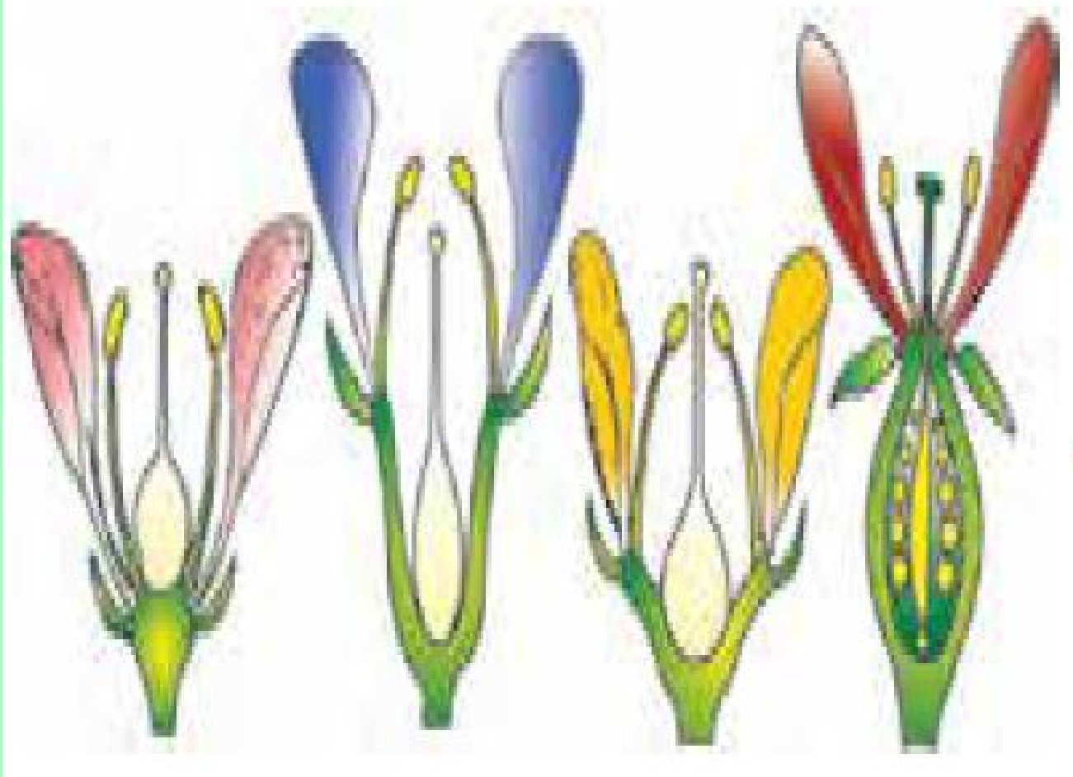
E.g., Grass, Banyan

Adventitious roots

Root Modifications

- Storage
  - Tap root: *E.g.,* Carrot, Turnip
  - Adventitious root: *E.g.,* Sweet potato, *Asparagus*
- Support
  - Prop root: *E.g.,* Banyan
  - Stilt root: *E.g.,* Maize, Sugarcane
- Respiration
  - Pneumatophores: *E.g., Rhizophora*

Position of floral parts on thalamus

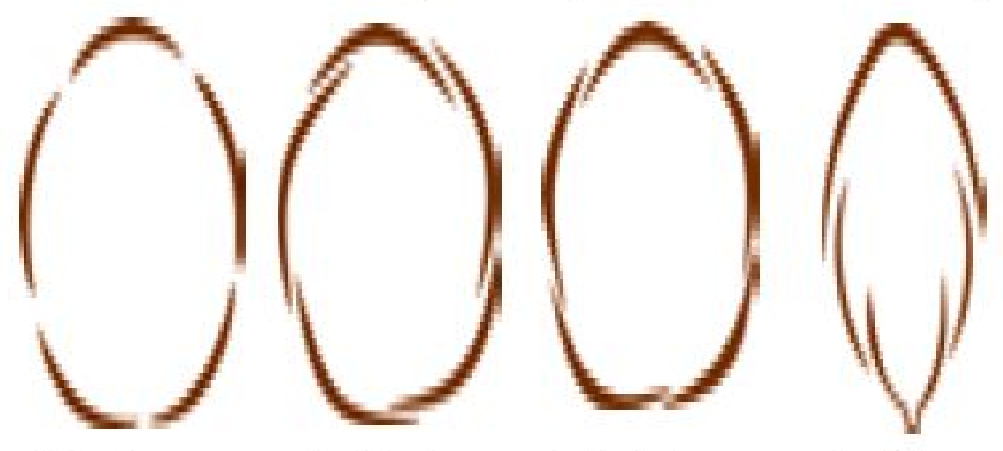

Hypogynous *e.g.,* China rose

Perigynous *e.g.,* Plum, Rose

Epigynous *e.g.,* Sunflower

Aestivation

The mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whorl is known as **aestivation.** The main types of aestivation are valvate, twisted, imbricate and vexillary.


Valvate *e.g., Calotropis*

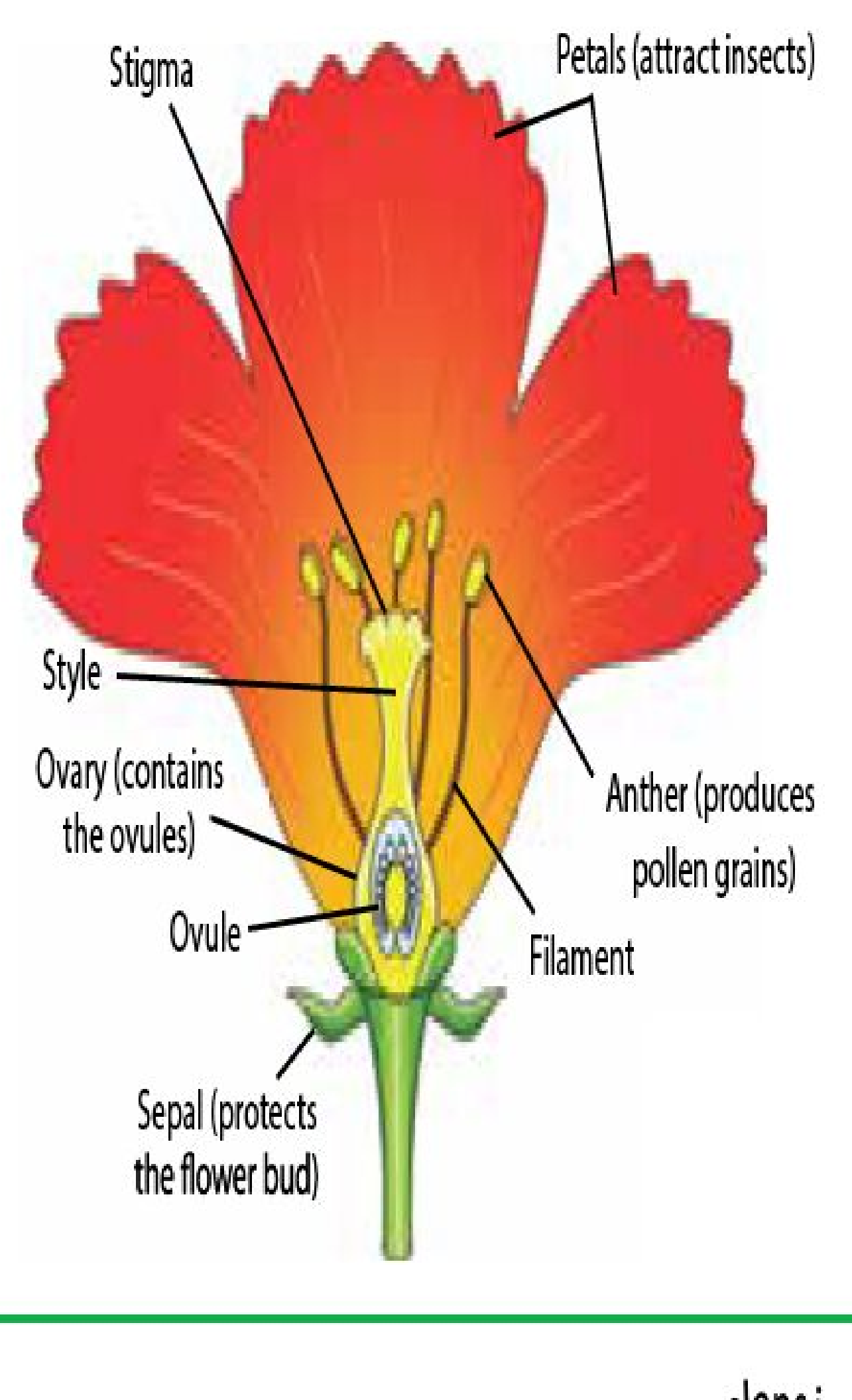
Twisted *e.g.,* China rose

Imbricate *e.g., Cassia*

Vexillary *e.g.,* Pea

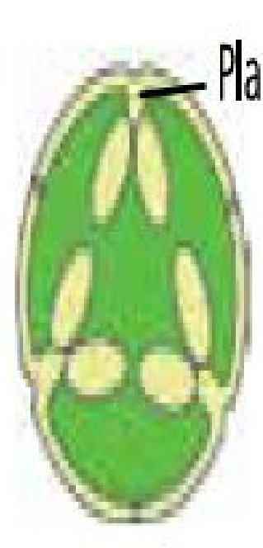
Flower

The flower is the unit for sexual reproduction in angiosperms. Calyx and corolla are accessory organs, while androecium and gynoecium are reproductive organs. In some flowers like lily, the calyx and corolla are not distinct and are termed as **perianth.**

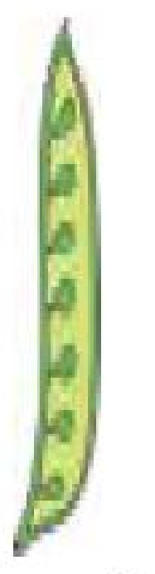

Stigma
Petals (attract insects)
Style
Ovary (contains the ovules)
Ovule
Anther (produces pollen grains)
Filament
Sepal (protects the flower bud)

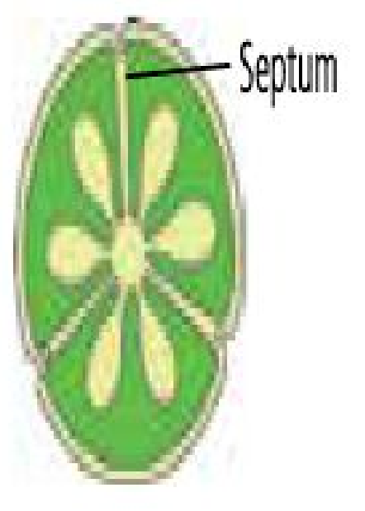
Placentation

Number, position, and arrangement of placentae inside an ovary is called **placentation.**

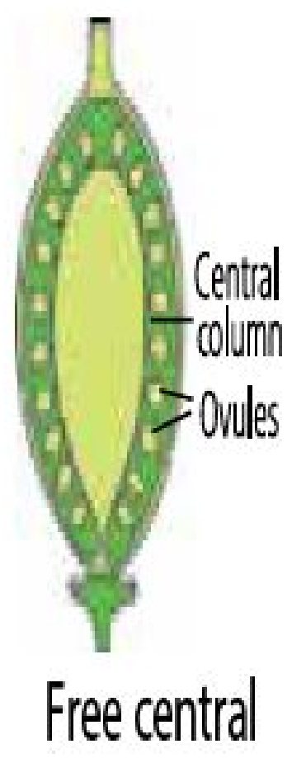


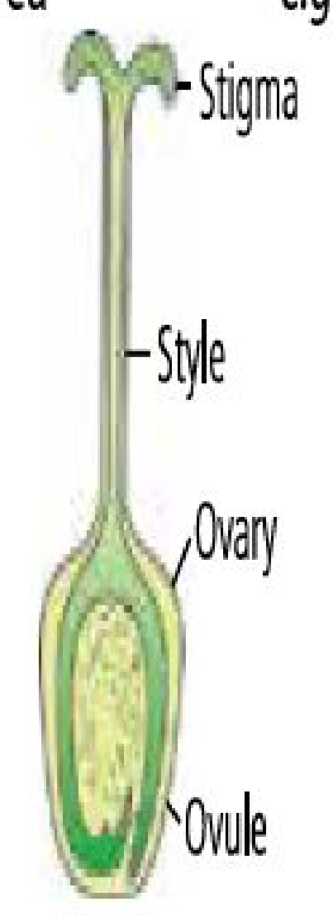
Parietal *e.g., Brassica*


Marginal *e.g.,* Pea



Axile *e.g., Hibiscus*

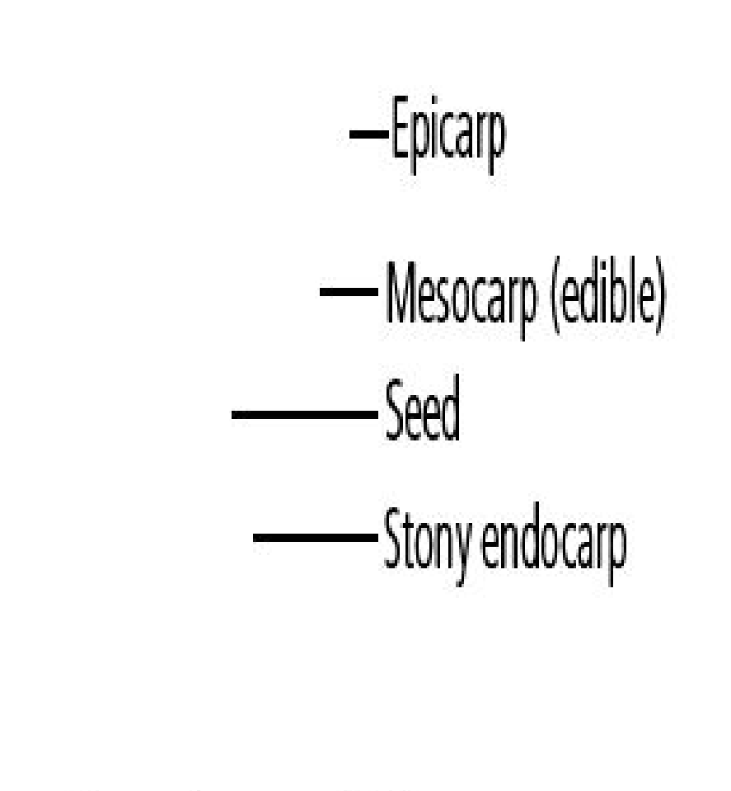

Central column
Ovules
Free central *e.g., Dianthus*


Stigma
Style
Ovary
Ovule
Basal *e.g.,* Sunflower

Fruit

The fruit is a mature or ripened ovary, developed after fertilisation and characteristic feature of the flowering plants. If a fruit is formed without fertilisation of the ovary, it is called a **parthenocarpic** fruit, *e.g.,* banana. In mango and coconut, the fruit is known as **drupe.**

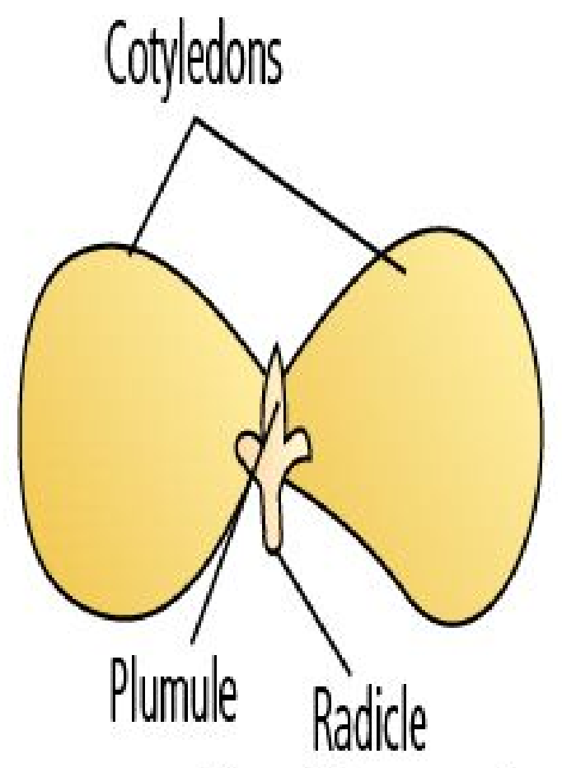
Develops into

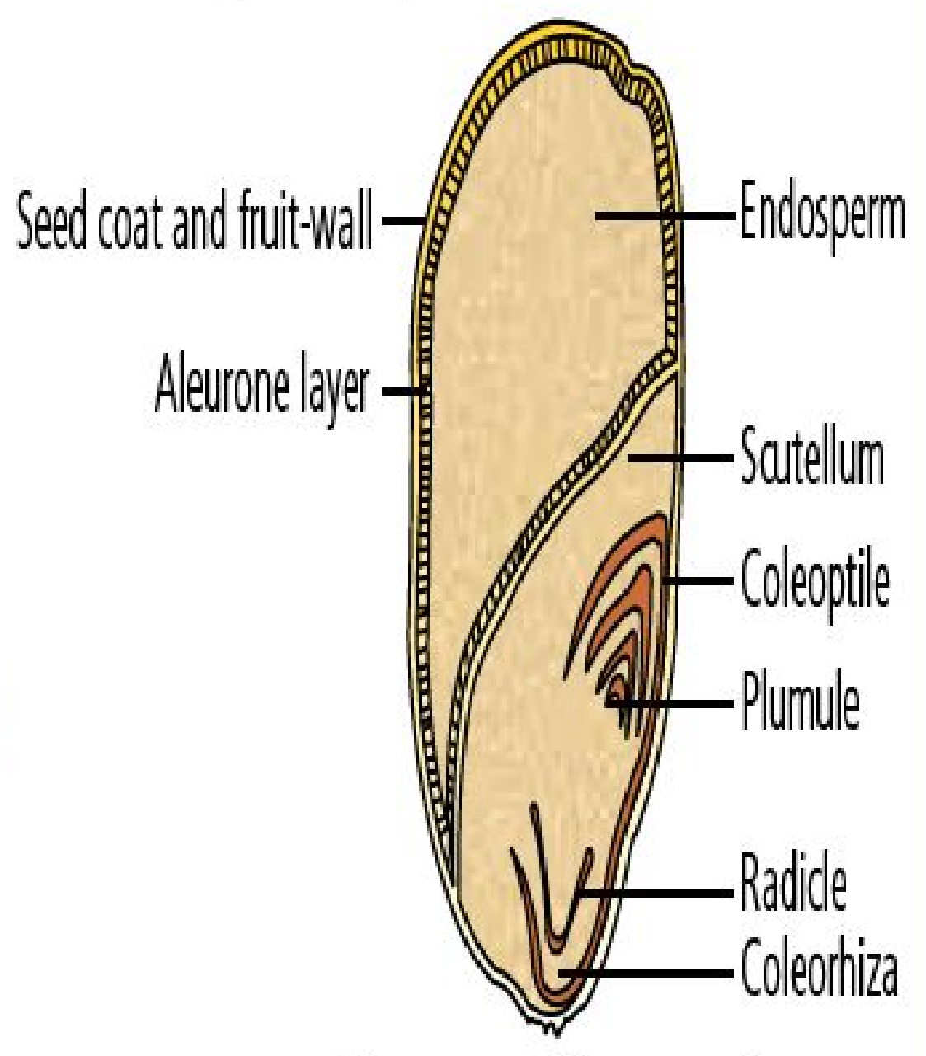

Epicarp
Mesocarp (edible)
Seed
Stony endocarp

Drupe of mango (L.S.)

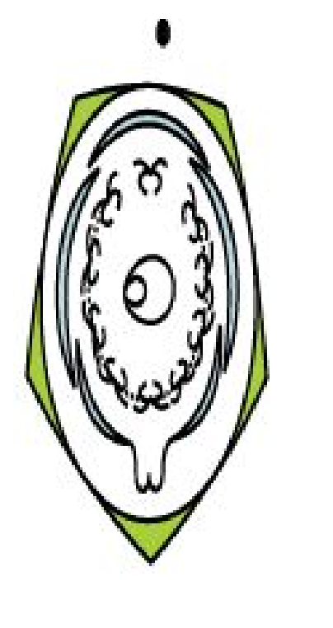
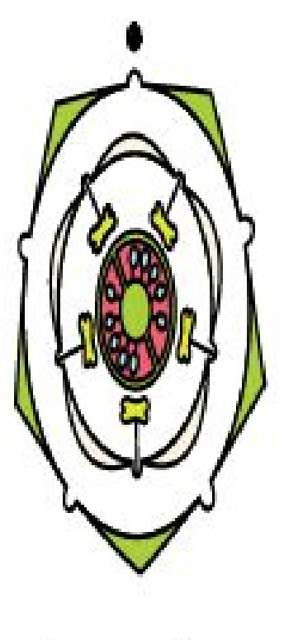
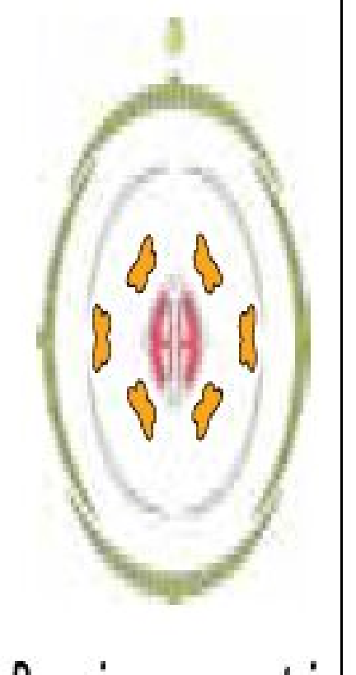
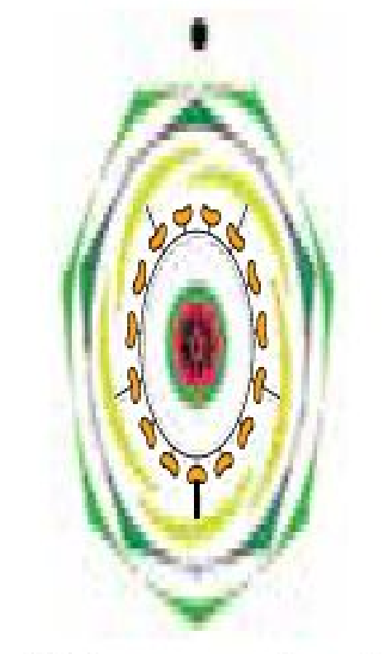
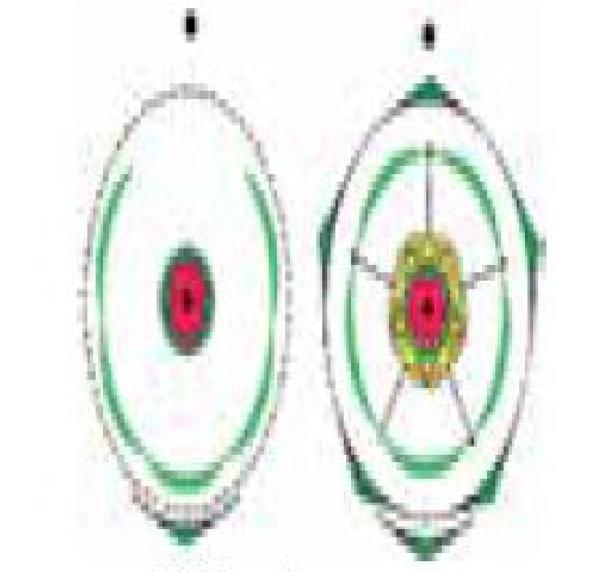
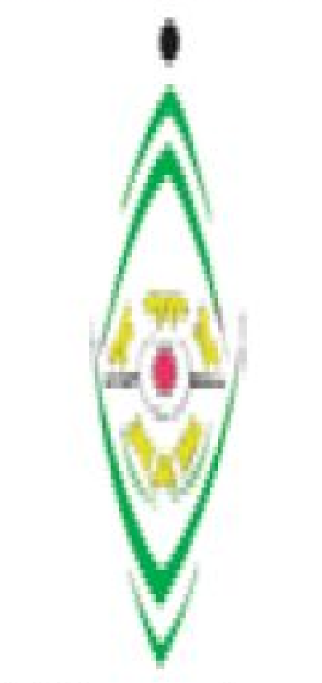
Seed

The ovules after fertilisation, develop into seeds. A seed is made up of a seed coat and an embryo. The embryo is made up of a radicle, an embryonal axis and one (as in wheat, maize) or two cotyledons (as in gram and pea).


Cotyledons
Plumule
Radicle
Structure of dicotyledonous seed


Seed coat and fruit-wall
Endosperm
Aleurone layer
Scutellum
Coleoptile
Plumule
Radicle
Coleorhiza
Structure of a monocotyledonous seed

Floral Diagram and Formula of Some Important Families

Fabaceae	Solanaceae	Brassicaceae	Malvaceae	Compositae	Gramineae
					
Pisum sativum	*Solanum nigrum*	*Brassica campestris*	*Hibiscus rosa-sinensis*	*Helianthus annuus*	*Triticum aestivum*
% ⚥ $K_{(5)} C_{1+2+(2)} A_{(9)+1} \underline{G}_1$	⊕ ⚥ $K_{(5)} \overset{\frown}{C_{(5)} A_5} \underline{G}_{(2)}$	⊕ ⚥ $K_{2+2} C_4 A_{2+4} \underline{G}_{(2)}$	⊕ ⚥ $Epi_{3-8} K_{(5)} \overset{\frown}{C_5 A_{(\infty)}} \underline{G}_{(2-\infty)}$	**Ray florets:** Br. % ♀ $K_{5(pappus)} C_{(5)} A_0 \overline{G}_{(2)}$ **Disc florets:** Br. ⊕ ⚥ $K_{5(pappus)} \overset{\frown}{C_5 A_5} \overline{G}_{(2)}$	Br. % ⚥ $P_{2(lodicules)} A_{3\text{ or }3+3} \underline{G}_1$

Cell Membrane

Cell or plasma membrane bounds the cytoplasm on the outerside and also covers the cell organelles inside the cytoplasm. Various models have been put forth to explain the structure of biomembrane but the most widely accepted one is fluid mosaic model.

Fluid mosaic model

It was proposed by Singer and Nicolson in 1972. Fluid mosaic model describes cell membrane as **'protein icebergs in a sea of lipids'**. According to this model, there is a bilayer of lipid molecules **(phospholipid)** with globular protein molecules (2 types- integral and peripheral) and **sterols** which are arranged in different manner in different regions of the plasma membrane.

Integral or transmembrane proteins go through the membrane. They have hydrophobic regions within the interior of the membrane and hydrophilic regions at the outer membrane surface.

Peripheral proteins are attached to the surface of the membrane, often to the exterior hydrophilic regions of the transmembrane proteins.

Functions

- Cell membranes cause compartmentalisation and allow organelles to maintain identity and internal environment.
- Protects cell from injury and allows flow of materials and information between different organelles as well as cells.
- Selective permeability of plasma membrane enables them to selectively allow some substances inwardly.
- It possess carrier proteins for facilitated and active transport.

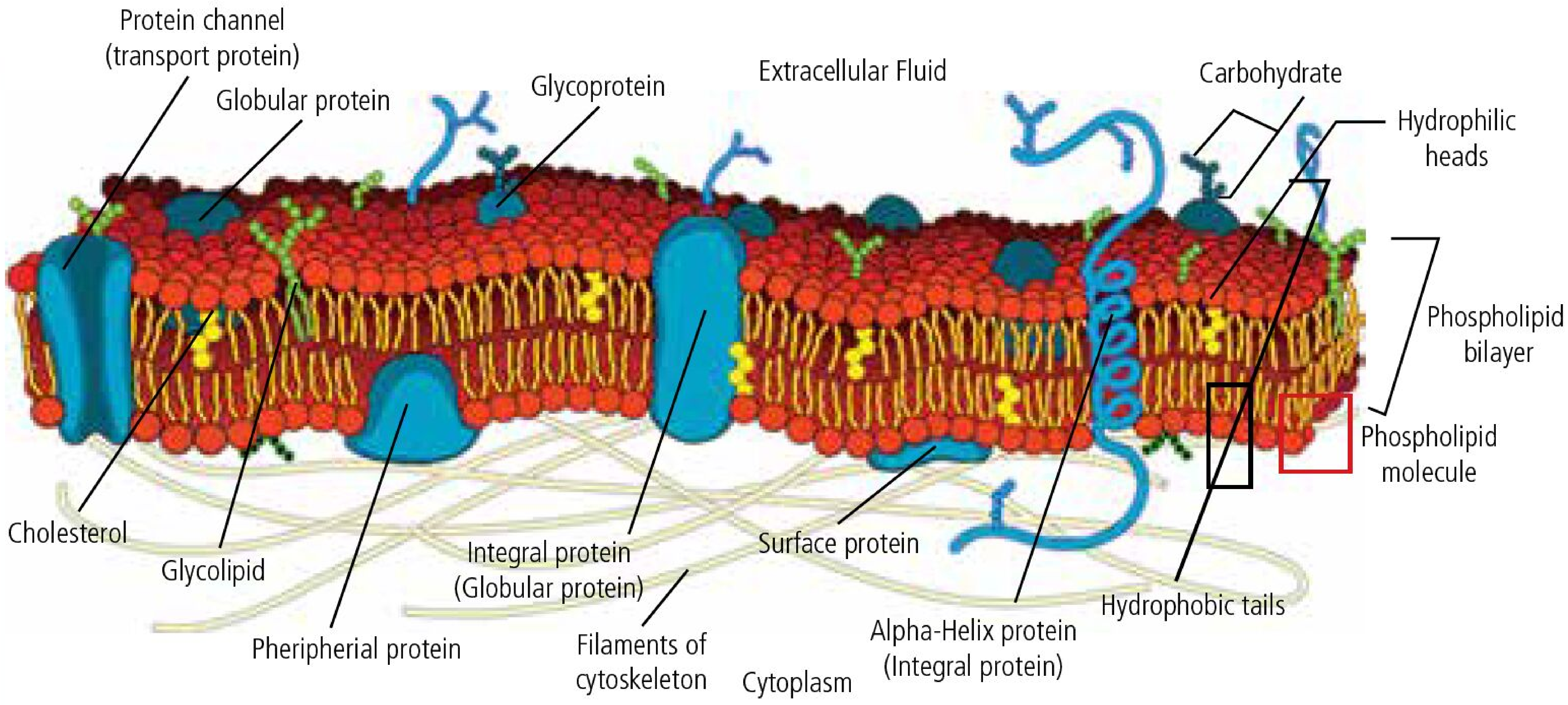

Protein channel (transport protein)
Globular protein
Glycoprotein
Extracellular Fluid
Carbohydrate
Hydrophilic heads
Phospholipid bilayer
Phospholipid molecule
Cholesterol
Glycolipid
Pheripherial protein
Integral protein (Globular protein)
Filaments of cytoskeleton
Cytoplasm
Surface protein
Alpha-Helix protein (Integral protein)
Hydrophobic tails

Fig.: Fluid Mosaic Model of Plasma Membrane

Cell Organelles

Cell organelles are sub-cellular structures with characteristic morphological forms, distinctive chemical constitutions and definite functions. An eukaryotic cell possess number of cell organelles.

Endomembrane system

It consists of membrane bound organelles which function in close coordination with one another, *viz.*, endoplasmic reticulum, Golgi complex, lysosomes and vacuoles. Nuclear envelope is also considered a part of endomembrane system as its lumen is in continuation with the lumen of endoplasmic reticulum. Organelles like plastids, mitochondria, peroxisomes and glyoxysomes are not a part of endomembrane system.

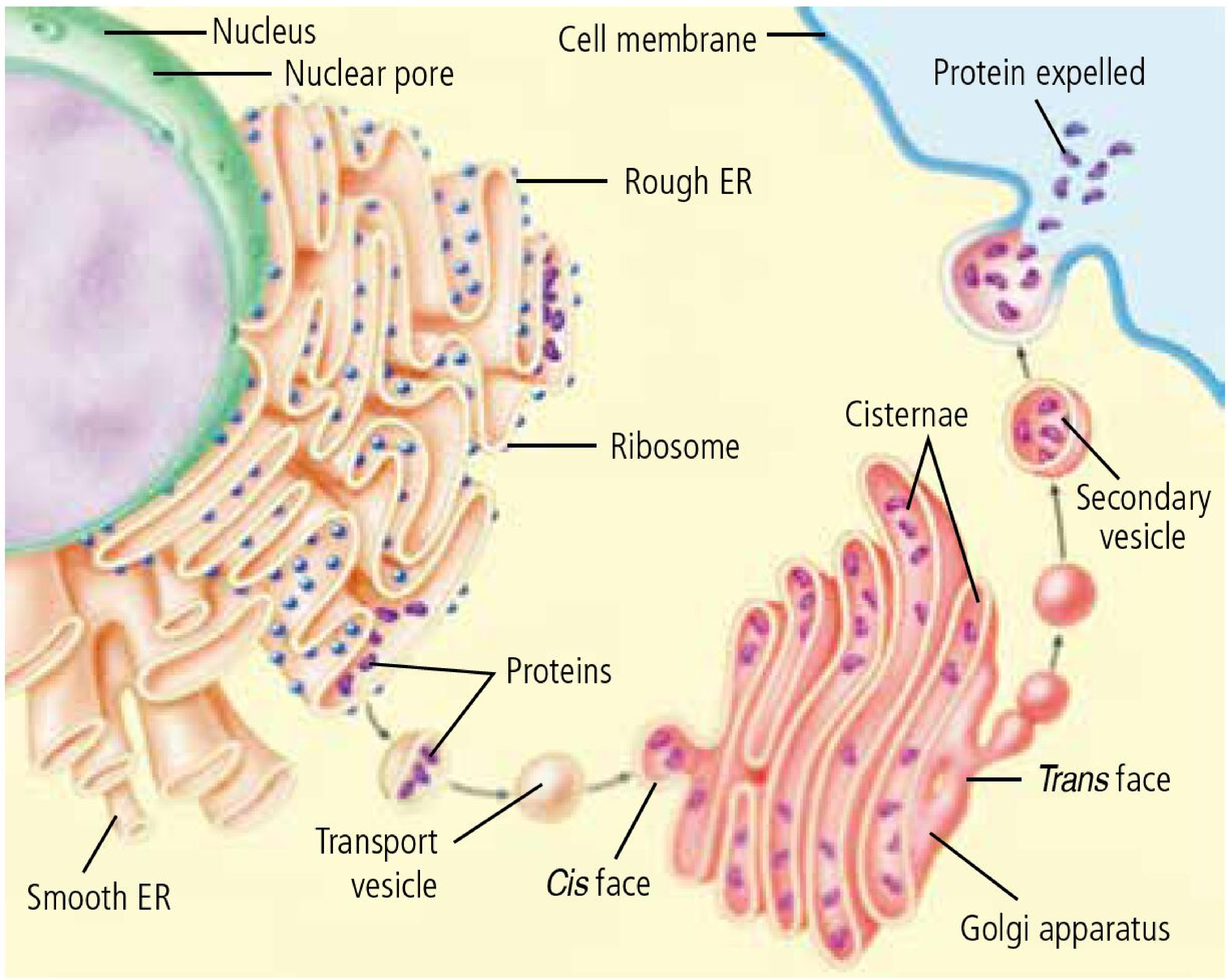

Nucleus
Nuclear pore
Cell membrane
Protein expelled
Rough ER
Ribosome
Cisternae
Secondary vesicle
Proteins
Trans face
Smooth ER
Transport vesicle
Cis face
Golgi apparatus

Fig.: Endomembrane System

Endoplasmic reticulum (ER)

It was discovered and named by **Porter** in 1945.

ER is a complicated and interconnected system of membrane lined channels that run through cytoplasm.

ER divides the intercellular space into two distinct compartments, *i.e.*, **luminal** (inside ER) and **extra luminal** (cytoplasm) compartments.

ER exists in three forms: **cisternae**, **vesicles** (oval sacs called as microsomes) and **tubules**.

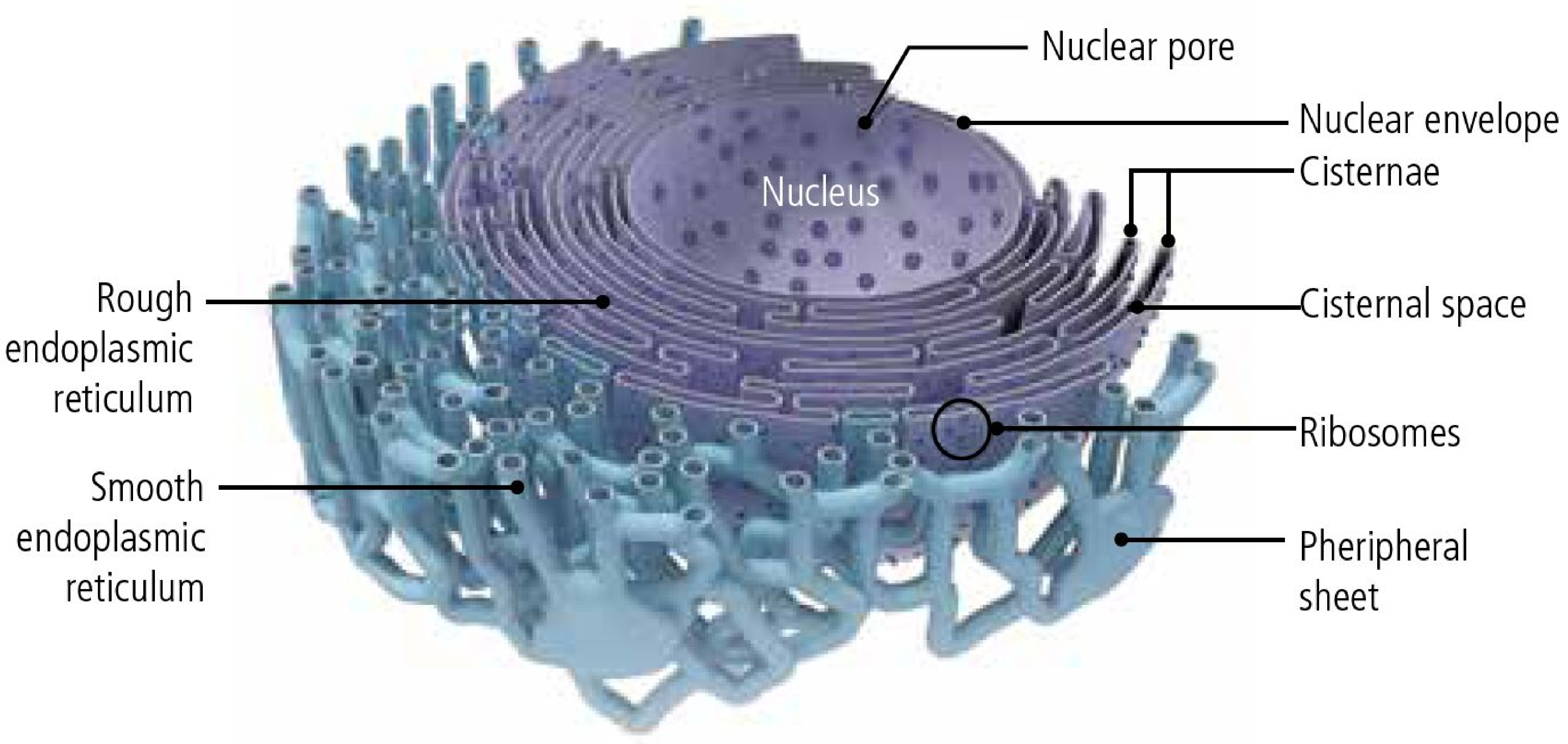

Nuclear pore
Nuclear envelope
Cisternae
Nucleus
Rough endoplasmic reticulum
Cisternal space
Ribosomes
Smooth endoplasmic reticulum
Pheripheral sheet

Fig.: Endoplasmic Reticulum

Types of endoplasmic reticulum

Characteristic	Smooth ER (SER)	Rough ER (RER)
Membrane	Smooth ER has smooth membranes due to absence of ribosomes.	Appears rough due to presence of number of ribosomes on membrane.
Occurrence	In glycogen storing liver cells, adipose cells, interstitial cells, etc. It is commonly found in leucocytes. It is usually peripheral and connected with plasmalemma. SER consists mainly of vesicles and tubules.	In cells which are actively engaged in protein synthesis and secretory activity, *e.g.*, pancreatic cells, plasma cells. RER is mostly made of **cisternae**. Tubules are very few. It is often internal and connected with nuclear envelope.
Functions	– **Detoxification** – Storage of glycogen, fat and sterol. – **Lipid synthesis** – Gives rise to sphaerosomes.	– Provides **surface for ribosome attachment** and protein synthesis. – **Forms SER** by loosing ribosomes. – Modification and packaging of newly formed proteins. – Helps in formation of lysosomes.

Golgi complex

Camillo Golgi, first observed Golgi bodies in the form of a network in nerve cells of barn owl and cat. Golgi bodies are present in all eukaryotic cells except in male gametes of bryophytes and pteridophytes, mammalian RBCs, sieve tubes of plants and in cells of fungi.

It is a complex cytoplasmic structure made up of smooth membrane saccules and other forms which takes part in membrane formation, secretion and production of complex biochemicals. Golgi apparatus is composed of unconnected units called **dictyosomes** in plants.

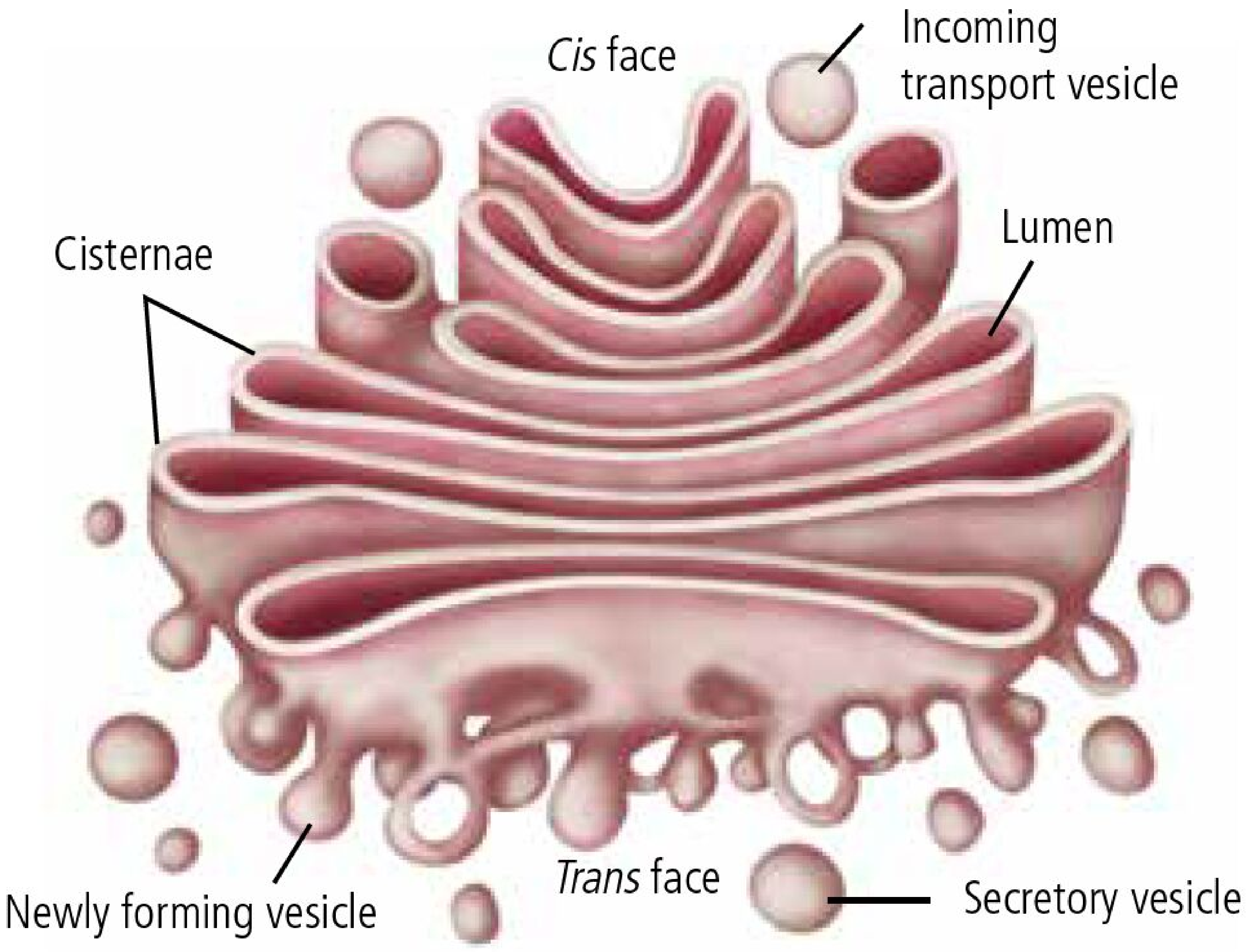

Cis face
Incoming transport vesicle
Cisternae
Lumen
Newly forming vesicle
Trans face
Secretory vesicle

Fig.: Golgi Apparatus

Parts of Golgi complex

1 Cisternae

Stack of 4-8 saccules is present in Golgi complex. Saccules are curved to give definite polarity to the Golgi apparatus. Convex side is called **forming** or *Cis*-face and concave side is **maturing** or *trans*-face.

2 Tubules

Tubules form a complicated network towards the periphery and maturing face of the apparatus. Actually tubules arise due to fenestrations of the cisternae and interconnect different cisternae.

3 Vesicles

Vesicles are small sacs attached to the tips of tubules at various levels in the network. They are of two types, **smooth** and **coated**. The coated vesicles have a rough surface. They elaborate membrane proteins. The smooth vesicles have a smooth surface. They contain secretory substances and are hence known as **secretion vesicles**.

4 Vacuoles

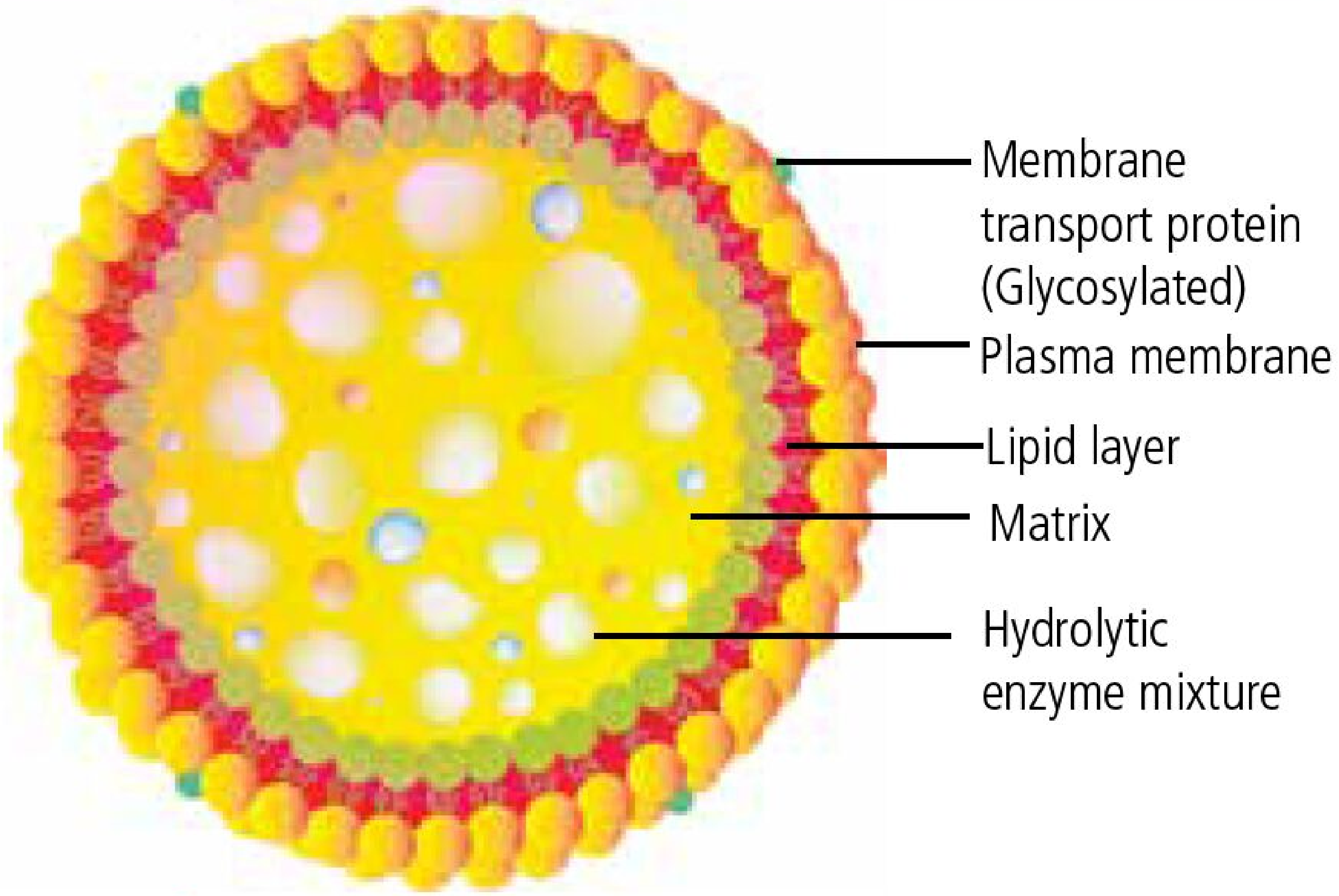
Golgian vacuoles are expanded parts of the cisternae. They develop from the maturing face and contain amorphous or granular substance. Some of the Golgian vacuoles function as **lysosomes.**

Functions

- Packaging and storage of materials.
- Secretion of different substances like gum, mucilage and hormones of endocrine glands.
- Acrosome formation during spermatogenesis.
- Glycosylation of proteins and lipids to form glycoproteins and glycolipids.
- Transformation and recycling of plasma membrane.

Lysosomes

Lysosomes first reported by **Christian de Duve** are single membrane bound, small vesicular organelles, containing hydrolytic enzymes. They are also called as **suicidal bags** owing to the presence of large number of digestive enzymes or **acid hydrolases** in them. Lysosomes are present in all animal cells **except RBCs**. In plant and fungi, **vacuoles** take over the function of lysosomes. There are four types of lysosomes on the basis of their morphology and function. The existence of more than one morphological form in same cell is referred to as **polymorphism**.



Membrane transport protein (Glycosylated)
Plasma membrane
Lipid layer
Matrix
Hydrolytic enzyme mixture

Fig.: Anatomy of the Lysosome

Functions

- Lysosomes help in digestion of useful substances for cell's use *i.e.*, intracellular digestion.
- Harmful (unwanted) material like pathogens, toxic material are disposed off by lysosomes. Thus, lysosomes are also called `**disposal bags'** or **disposal units**.
- Lysosomal enzymes are used by sperm for breaking limiting membrane of egg thus, aid in fertilisation.
- They are recycling centres of cell and help in renewal of worn out cells and organelles.
- In the thyroid gland, thyroglobulin is hydrolysed by lysosomal enzymes to form active thyroxine hormone.

Vacuoles

Vacuoles are non-cytoplasmic areas present inside the cytoplasm. These are surrounded by single membrane called tonoplast. They are formed by expansion and pinching off from endoplasmic reticulum. They are small in animal cell and large in fungal and plant cells. Vacuoles may be of four types, depending upon its contents and functions.

Types of vacuoles

Food vacuole

- Helps in food digestion.
- It contains digestive enzymes which help in digestion of nutrients.

Sap vacuole

- Maintains osmotic pressure and turgidity.
- Stores water soluble vacuolar pigments *e.g.*, anthocyanin.

Air vacuole

- Stores gases
- It also provides buoyancy, mechanical strength and protection from harmful radiations.

Contractile vacuole

Regulates osmoregulation and excretion.

Mitochondria

Mitochondria are cell organelles of aerobic eukaryotes which take part in oxidative phosphorylation and Kreb's cycle of aerobic respiration. They are called **power houses** of cell because they are the major centres of release of energy in the aerobic respiration. They were first observed by **Kolliker**, but the term mitochondria was given by **Benda**.

Mitochondria are absent in prokaryotes and anaerobic eukaryotes. Mitochondria are secondarily lost in the red blood corpuscles of mammals. Its number depends upon cellular activities. Cells of dormant seeds have very few mitochondria, while those of germinating seeds have several mitochondria.

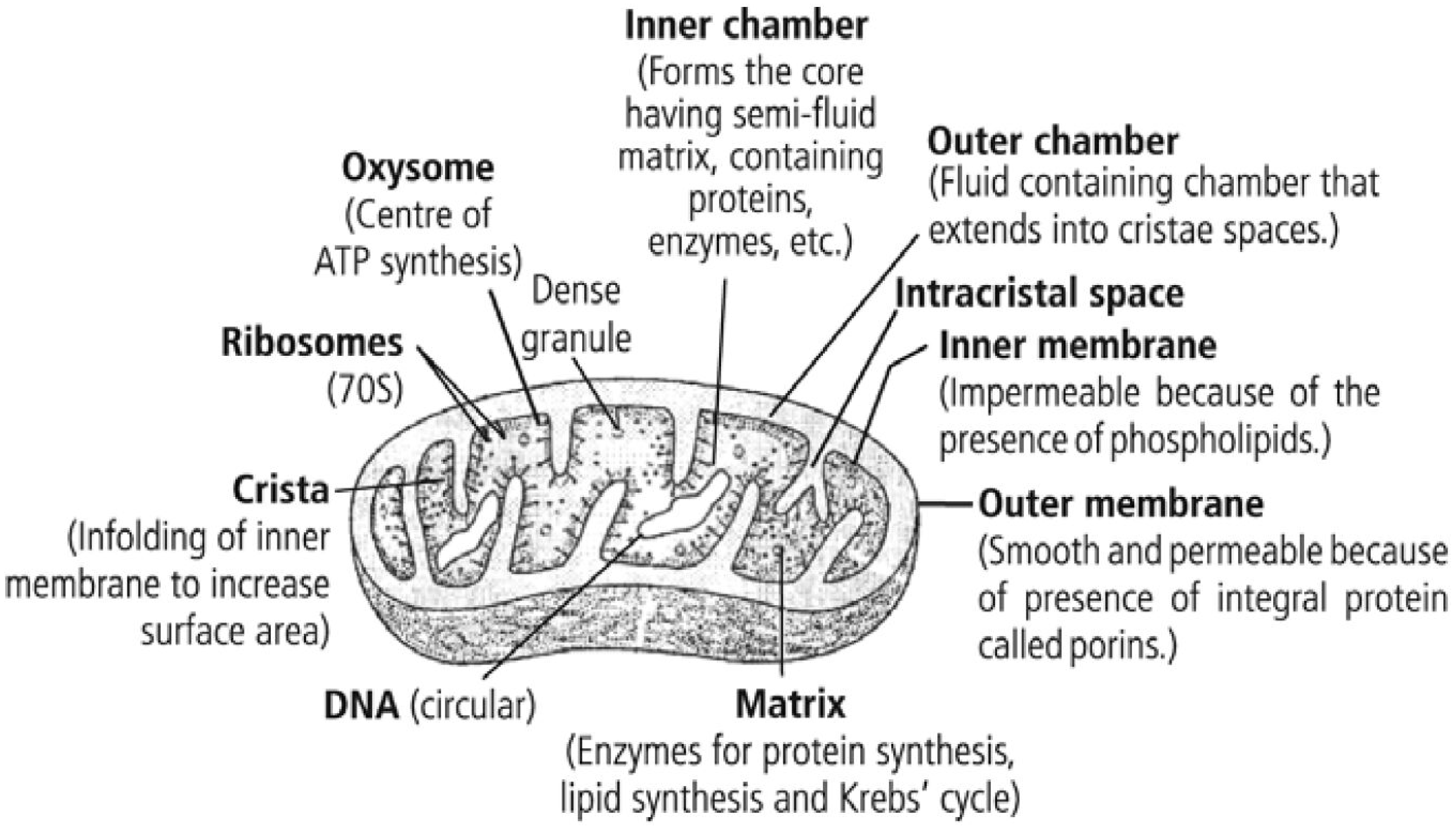

Inner chamber
(Forms the core having semi-fluid matrix, containing proteins, enzymes, etc.)
Outer chamber
(Fluid containing chamber that extends into cristae spaces.)
Oxysome
(Centre of ATP synthesis)
Dense granule
Intracristal space
Ribosomes
(70S)
Inner membrane
(Impermeable because of the presence of phospholipids.)
Crista
(Infolding of inner membrane to increase surface area)
Outer membrane
(Smooth and permeable because of presence of integral protein called porins.)
DNA (circular)
Matrix
(Enzymes for protein synthesis, lipid synthesis and Krebs' cycle)

Fig.: Ultrastructure of a Mitochondrion

Functions of mitochondria

- Mitochondria act as sites of cellular respiration where food stuff or respiratory substrates are completely oxidised to carbon dioxide and water and form energy rich ATP. ATP helps in performing various energy requiring processes, therefore, called as **power house** of cell.
- Mitochondria provide important intermediates for the synthesis of several biochemicals like chlorophyll, cytochromes, pyrimidines, steroids, alkaloids, etc.
- The **matrix** or inner chamber of the mitochondria has enzymes for the **synthesis of fatty acids**. Enzymes required for the elongation of fatty acids have been reported in the outer mitochondrial chamber.
- Synthesis of many amino acids occurs in the mitochondria. The first formed amino acids are glutamic acid and aspartic acid.

Plastids

The term plastid was introduced by **E. Haeckel** in 1866. With the exception of some protists, (*e.g.*, *Euglena*, dinophyceae, diatoms) **plastids are restricted to plants only**. Plastids are **semi-autonomous** organelles having DNA and double membrane envelope which store or synthesise various types of organic compounds. Plastids develop from colourless precursors called **proplastids** which have the ability to divide and differentiate into various types of plastids.

Types of plastids

Leucoplasts

Colourless, occur in non-green cells. Their main function is storage. According to the stored products they are **Amyloplasts** (store starch), **Elaioplasts** or lipidoplasts or oleoplasts (store lipids or fat) and **Aleuroplasts** or proteoplasts or proteinoplasts (store proteins).

Chromoplasts

Yellow or reddish in colour due to presence of carotenoid pigments. They lack chlorophyll. They are mainly present in cells of petals and ripe fruit and impart them various colours. They also synthesise membrane lipids.

Chloroplasts

Greenish in colour, contain photosynthetic pigments-chlorophylls and carotenoids. Synthesise food from inorganic materials, using light energy.

Chloroplasts

The number of chloroplasts in a cell varies from species to species but remains fixed to a particular species *e.g.*, one in *Ulothrix*, photosynthetic leaf has 20-40 chloroplasts.

Similarly the shape and size of chloroplast also differs with species. It may be cup-shaped in *Chlamydomonas*, ribbon- like in *Spirogyra*, disc-shaped and oval in higher plants.

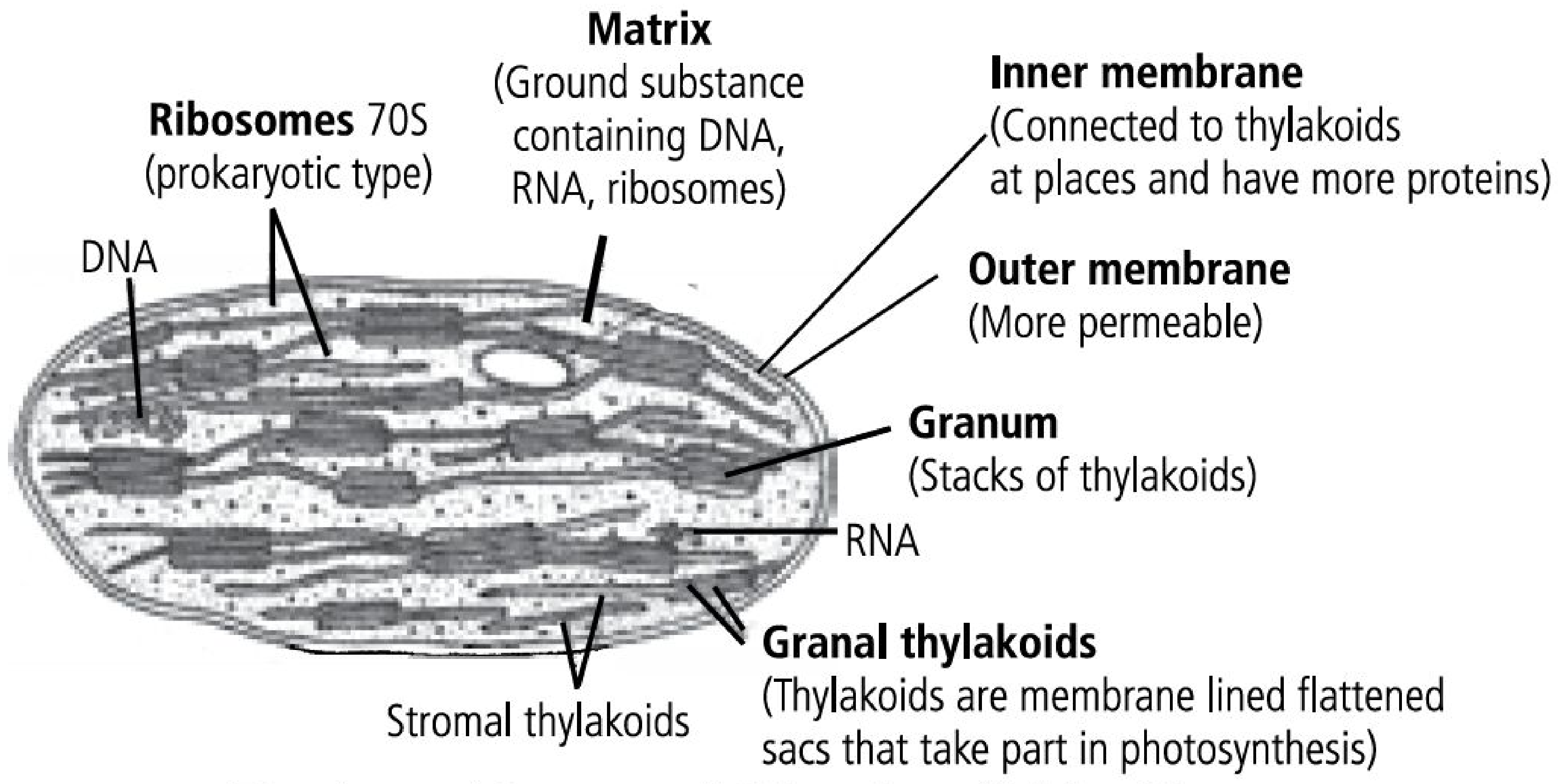

Matrix
(Ground substance containing DNA, RNA, ribosomes)
Ribosomes 70S
(prokaryotic type)
DNA
Inner membrane
(Connected to thylakoids at places and have more proteins)
Outer membrane
(More permeable)
Granum
(Stacks of thylakoids)
RNA
Granal thylakoids
(Thylakoids are membrane lined flattened sacs that take part in photosynthesis)
Stromal thylakoids

Fig.: Internal Structure of Chloroplast of Higher Plants

Functions

Energy transduction

- Chloroplasts have unique ability to trap solar energy and transform it into chemical energy, which is essential for all living organisms to support their life activities.

Photosynthesis

- Chloroplasts are the centres of photosynthesis or formation of organic compounds from inorganic raw materials.

Consumption of CO_2

- They pick up carbon dioxide and use the same in photosynthesis. Thus, keep the percentage of carbon dioxide balanced in the atmosphere as it is being constantly added through respiration and combustion.

Liberation of oxygen

- Chloroplasts liberate oxygen which is passed into the atmosphere. Thus, keep the balance of oxygen constant in the atmosphere since it is being used up in respiration and combustion.

Microbodies

Minute, simple, spherical sacs, bounded by single unit membrane which absorb molecular oxygen and take part in oxidation.

Peroxisomes

Contain enzymes for peroxide biosynthesis. Found in both plant and animal cells, generally in close association with endoplasmic reticulum, mitochondria and chloroplasts.

Glyoxysomes

Contain enzymes for β-oxidation of fatty acids and glyoxylate pathway. Acetyl Co-A produced by β oxidation of fatty acids is metabolised in glyoxylate cycle to produce carbohydrates. Following this, they convert back into peroxisomes.

Ribosomes

Ribosomes are submicroscopic, naked (without membrane) ribonucleoprotein (RNP) protoplasmic particles.

Ribosomes were discovered in plant cell by **Robinson** and **Brown** and **Palade** in animal cell. **Palade coined the term ribosome** hence, they are also called **Palade particles**.

The ribosomes are subspherical in outline and consist of two unequal subunits.

On the basis of **sedimentation coefficient** or **Svedberg unit** ribosomes are of two types – **80S ribosomes** (found in eukaryotes, have two subunits, 60S and 40S) and **70S ribosomes** (found in prokaryotes, have two subunits 50S and 30S).

During protein synthesis many ribosomes line up and join an *m*RNA chain. This string of ribosomes is called **polysome**.

Function

Ribosomes are the sites for polypeptide or protein synthesis, hence called as **protein factories of cell**. Structural proteins are produced by free cytoplasmic ribosomes while those attached to ER synthesise globular proteins.

Cytoskeletal Structures

These are extremely minute, fibrous and tubular structures forming the framework inside a cell. They are found only in eukaryotes. They maintain shape of cell, its extension, regulate orientation and distritbution of cell organelles and movement of cells, etc.

Types of cytoskeletal structures

Microfilaments

Microfilaments are found in all eukaryotic cells forming an extensive network in cytoplasm of non-muscle cells.
They are solid, unbranched, rod-like fibrils of indefinite length, about 50 – 60 Å in diameter and composed mainly of a globular protein **actin** but have some filamentous protein myosin also.

Functions : They produce streaming movements (cyclosis) of cytoplasm and cause cleavage of animals. Myofilaments bring about muscle contraction. They cause movement of villi to quicken absorption of food and are also responsible for the change in cell shape.

Intermediate filaments

The intermediate filaments are supportive elements in the cytoplasm of eukaryotic cells, except the plant cells. The IFs are about 10 nm thick, solid, unbranched and composed of non-motile structural proteins such as keratin, desmin, vimentin. Each IF is formed of 8 protofilaments.

Functions : They form a part of cytoskeleton that supports the fluid cytosol and maintains the shape of the cell. They form major structural proteins of skin and hair and integrate the muscle cell components into a functional unit.

Microtubules

The microtubules are hollow, unbranched cylinders, about 25 nm wide and 5 nm thickness. They may occur singly or in bundles and radiate from the centrioles to the periphery of the cell. The wall of a microtubule is composed of 13 parallel **protofilaments** that enclose a central lumen about 150 Å wide. Each protofilament is made up of a row of globular subunits formed of a protein **tubulin**. Each subunit contains one α-tubulin molecule and one β-tubulin molecule, which are arranged alternately in a helical manner.

Functions : Microtubules are constituents of spindle fibres, chromosome fibres, centrioles, basal bodies, flagella and cilia. Microtubules function as cytoskeleton and provide rigidity and shape to certain cell parts like pseudopodia of some protistans and elongated axons of nerve cells.

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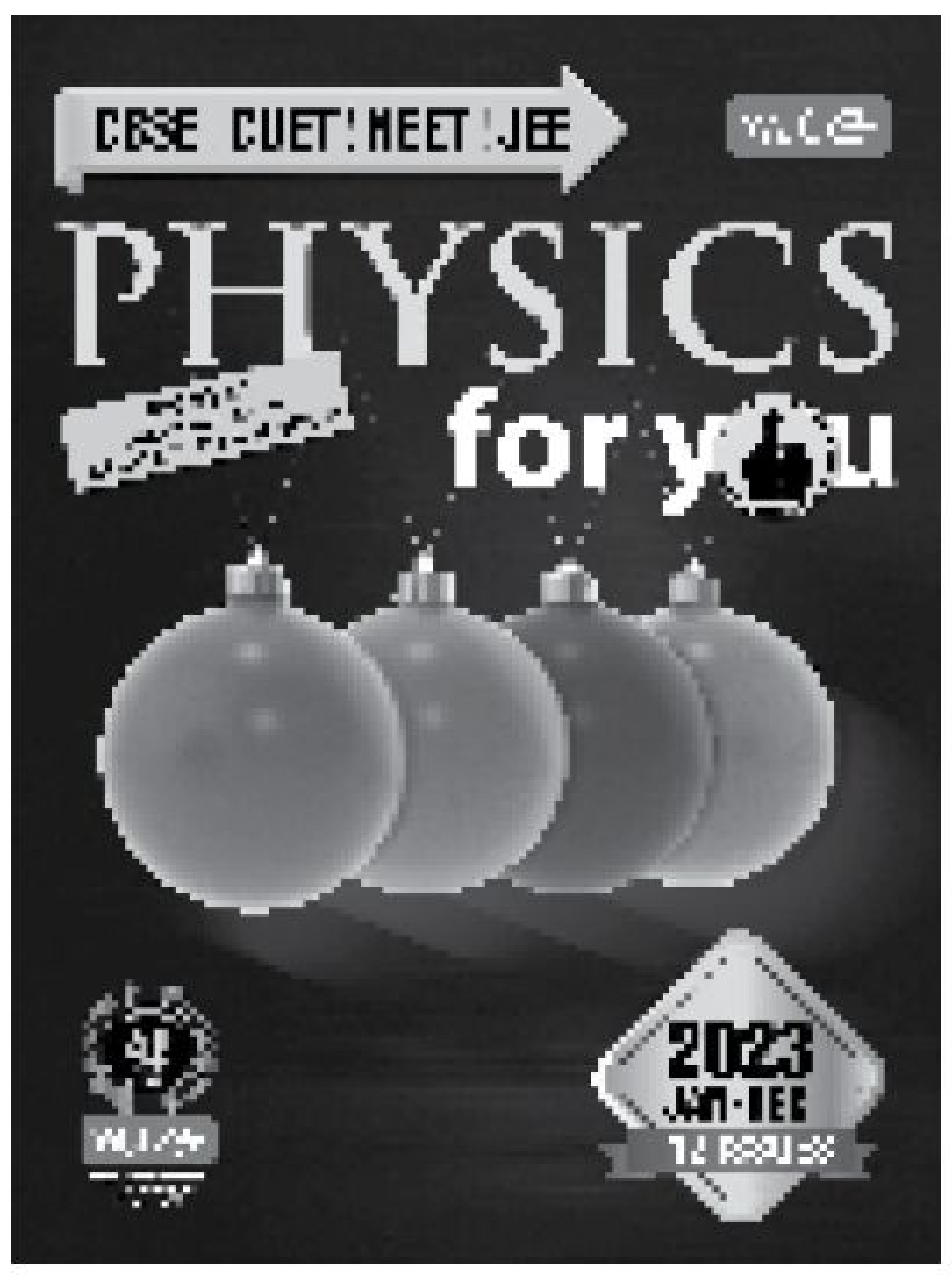

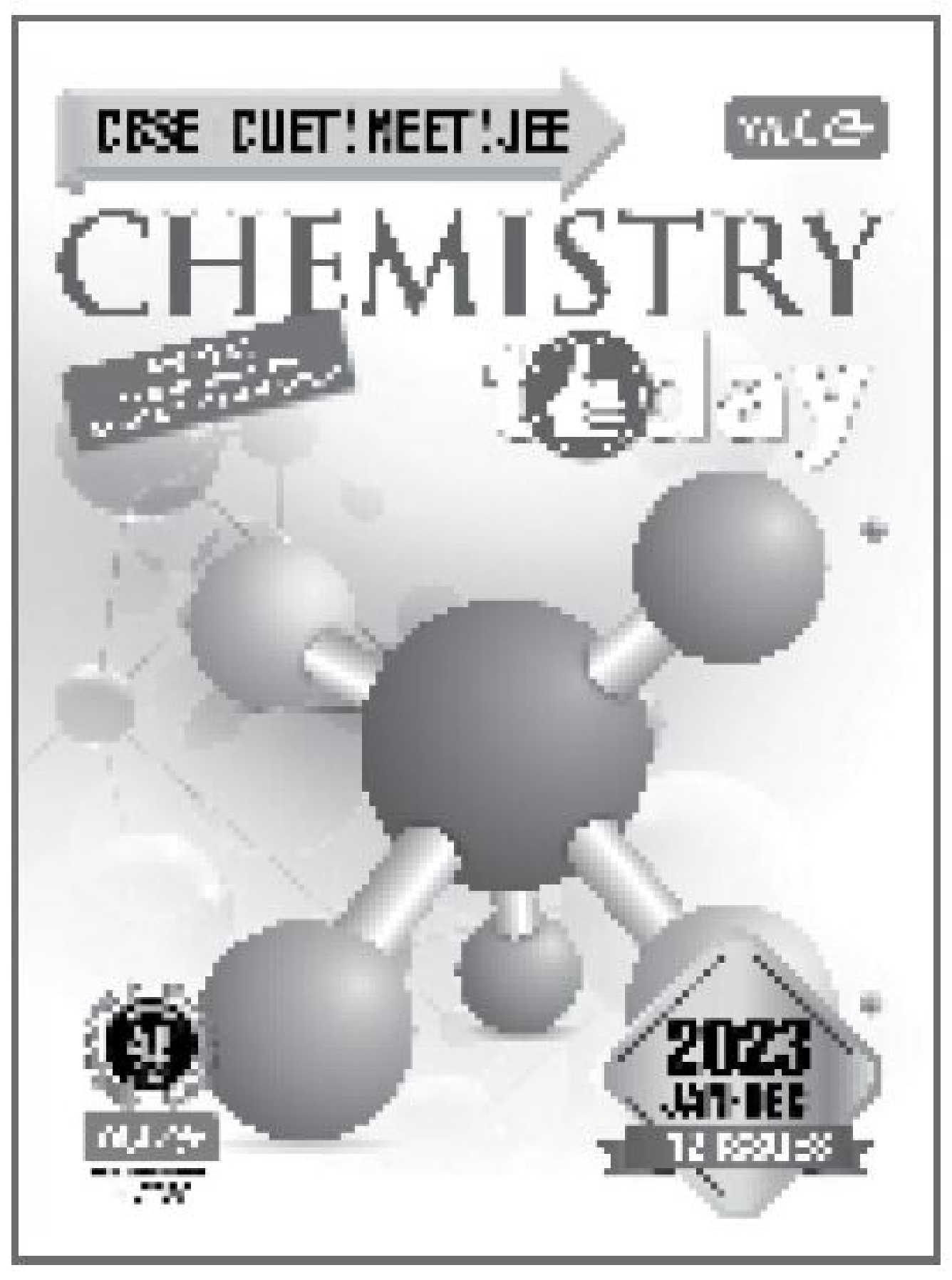

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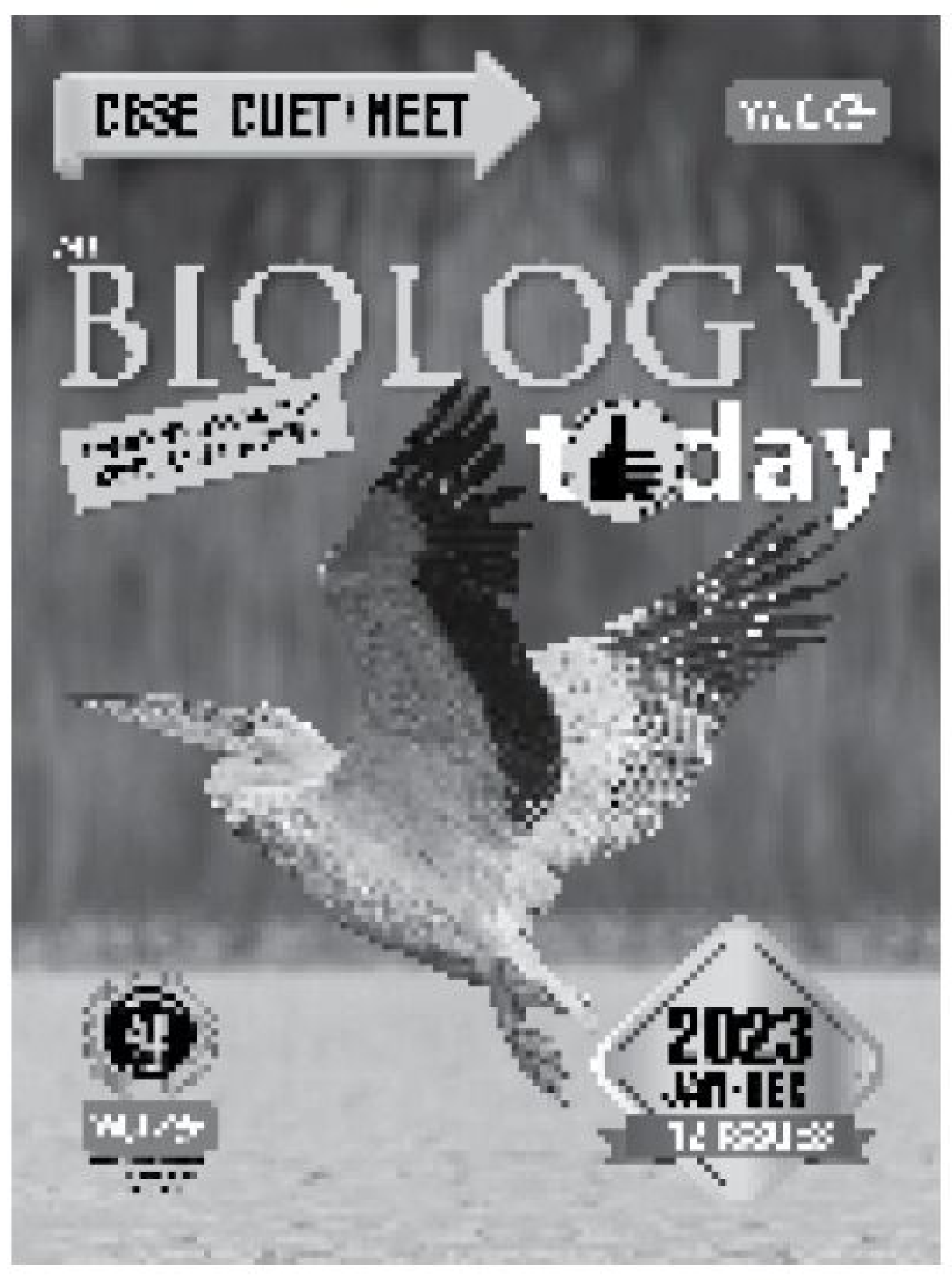

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Cilia and flagella

The cilia and flagella are microscopic, contractile and filamentous processes of the cytoplasm which are capable of producing a current in fluid medium for locomotion and passage of substances. Both arise from the basal bodies, are similar in chemical composition, have basically identical ultrastructure, and serve the same purpose. However, the two are distinguishable by their number, size, mode of beating.

Table : Differences between Cilia and Flagella

	Cilia	Flagella
1.	The number of cilia per cell is usually very large (300–14000).	The number of flagella per cell is usually 1–4.
2.	They are smaller (5–20μm in length).	They are longer (100–200 μm in length).
3.	Cilia usually occur throughout or major part of the surfaceof a cell.	Flagella are commonly found at one end of the cell.
4.	Cilia help in locomotion, aeration, feeding, circulation, etc.	Flagella help in locomotion.
5.	Surface is smooth.	Surface may be smooth or possess flimmers.

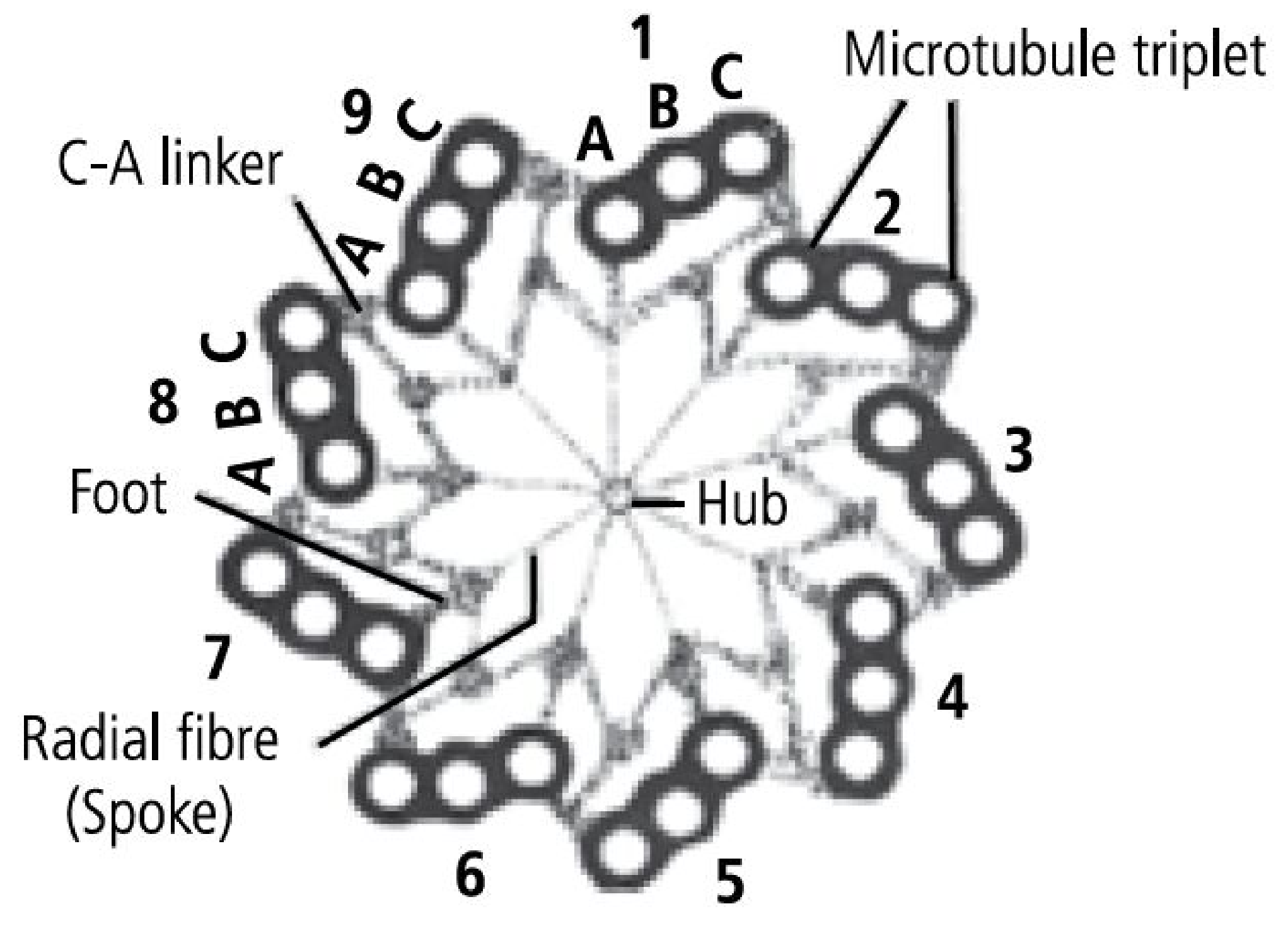
Centriole

Centrioles are minute (submicroscopic), microtubular, subcylinder, found in almost all eukaryotic animal cells, some fungi and plants with flagellated structures in life cycle.

A centriole possesses a whorl of nine peripheral fibrils. Fibrils are absent in centre forming (9 + 0) arrangement. Each fibril is made up of three sub-fibres called **triplet fibril**. From outside to inside these three sub-fibres are named C, B and A. The adjacent triplet fibrils are connected by C – A proteinaceous linkers. The centre of centriole possesses a rod-shaped proteinaceous mass known as **hub**. From the hub, 9 proteinaceous strands develop towards the peripheral triplet fibrils. They are called **spokes**.

Functions

- Centrioles can be transformed into basal bodies which give rise to cilia and flagella.
- Centrioles help in cell division by forming astral poles or microtubules-organising centres (MTOCs)


1
A
B
C
Microtubule triplet
9
C
B
A
C-A linker
2
8
C
B
A
3
Foot
Hub
7
4
Radial fibre
(Spoke)
6
5

T. S. of Centriole

Nucleus

Nucleus is a specialised double membrane bound protoplasmic body which contains all the genetic information for controlling cellular metabolism and inheritance. It is one of the most important and the largest cytoplasmic organelle, present in all eukaryotic cells **except mature RBCs** and **mature sieve cells** of vascular plants. It is well organised in eukaryotes but in prokaryotic cells it is of primitive nature called **prokaryon** or **nucleoid.**

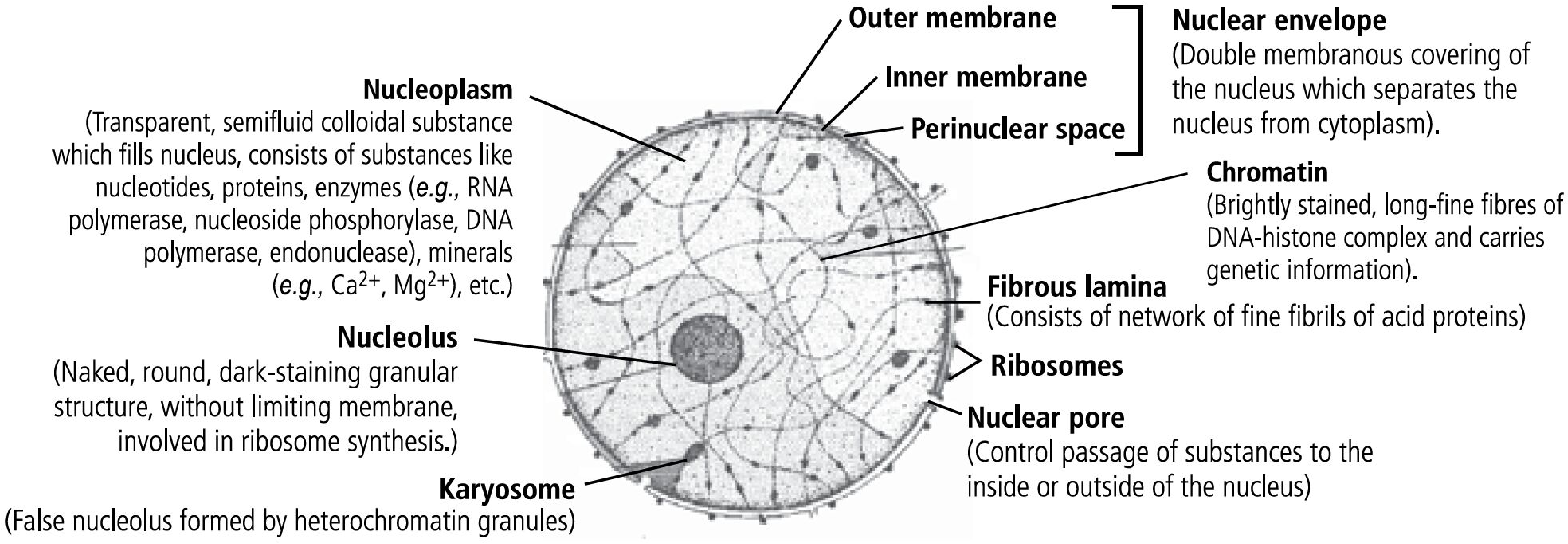

Outer membrane
Inner membrane
Perinuclear space
Nuclear envelope
(Double membranous covering of the nucleus which separates the nucleus from cytoplasm).
Nucleoplasm
(Transparent, semifluid colloidal substance which fills nucleus, consists of substances like nucleotides, proteins, enzymes (e.g., RNA polymerase, nucleoside phosphorylase, DNA polymerase, endonuclease), minerals (e.g., Ca2+, Mg2+), etc.)
Chromatin
(Brightly stained, long-fine fibres of DNA-histone complex and carries genetic information).
Fibrous lamina
(Consists of network of fine fibrils of acid proteins)
Nucleolus
(Naked, round, dark-staining granular structure, without limiting membrane, involved in ribosome synthesis.)
Ribosomes
Nuclear pore
(Control passage of substances to the inside or outside of the nucleus)
Karyosome
(False nucleolus formed by heterochromatin granules)

Fig.: Ultrastructure of Interphase Nucleus

Class XII

BIO Digest

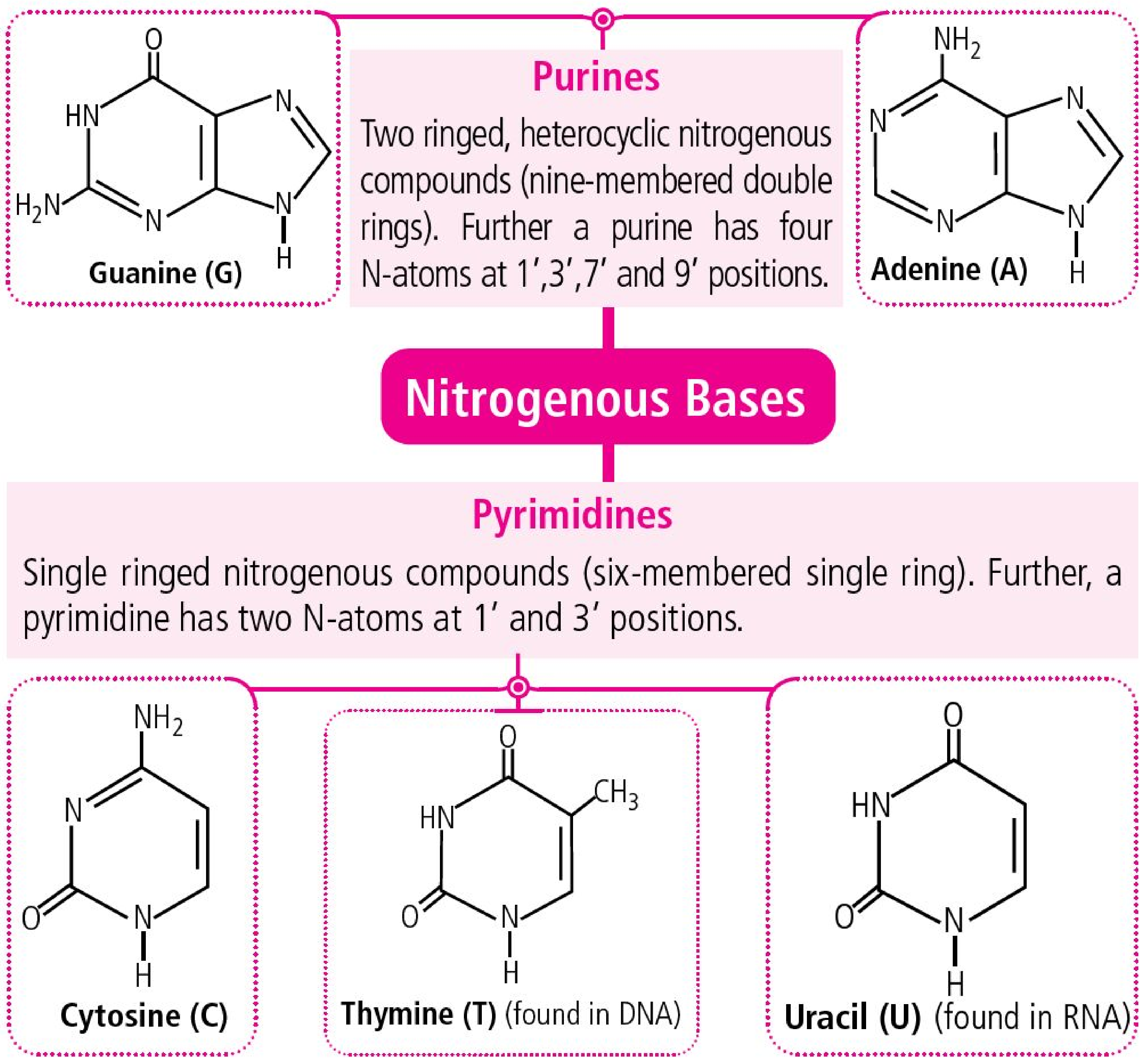
This article covers high yield facts of the given topic.

Molecular Basis of Inheritance

- Genetic material is the substance which controls the formation and expression of traits in an organism. Inheritance of characters from one generation to the next is also based upon the transfer of **genetic material** from parents to progenies. Genetic material must possess four major characteristics - replication, storage of information, expression of information and variation by mutation.
- The genetic material must be able to serve as a **repository of genetic information**, whether it is expressed or not. It should be able to accurately pass its copies into the progeny. **Replication** allows the genetic material to precisely duplicate itself forming the exact copies.
- Expression of stored genetic information is the basis for the concept of **information flow** within the cell.
- The genetic material must also serve as the basis of newly arising variability among organisms through the process of **mutation**.

DEOXYRIBONUCLEIC ACID (DNA)

- DNA is the **largest macromolecule** which consists of two complementary strands of **deoxyribonucleotides** that run antiparallely.
- It is composed of small monomeric units called **nucleotides** (deoxyribonucleotides) made up of a **pentose sugar** (deoxyribose type), a **phosphate group** and a **nitrogenous base**.



Purines

Two ringed, heterocyclic nitrogenous compounds (nine-membered double rings). Further a purine has four N-atoms at 1′,3′,7′ and 9′ positions.

Nitrogenous Bases

Pyrimidines

Single ringed nitrogenous compounds (six-membered single ring). Further, a pyrimidine has two N-atoms at 1′ and 3′ positions.

Guanine (G)

Adenine (A)

Cytosine (C)

Thymine (T) (found in DNA)

Uracil (U) (found in RNA)

- The pentose sugar and the nitrogenous base constitute **nucleosides**. Nitrogen base is linked to pentose sugar through N-glycosidic linkage to form a nucleoside. There are four nucleosides in DNA, differ from each other in the type of the nitrogenous base which could be **adenine** (A), **guanine** (G), **thymine** (T) or **cytosine** (C).

Structure and Function of DNA

- The linkage between two nucleotides consists of a phosphate group linked to two sugars. A **phosphodiester bond** is formed between C-3 and C-5 of different deoxyribose sugars of two adjacent nucleotides.
- One end of the polynucleotide chain has a sugar residue with C-3, not linked to another nucleotide having free 3′–OH group and the other end has sugar residue with C-5, linked to a phosphate group thus, showing **polarity.** These are named as 3′ and 5′ ends respectively.
- The two polynucleotide chains are **antiparallel** to each other. One has phosphodiester linkage in $3' \rightarrow 5'$ direction while the other has phosphodiester linkage in $5' - 3'$ direction. The two polynucleotide chains are held together by **hydrogen bonding** between specific pairs of purines and pyrimidines.
- The pairing is always between **A** and **T,** and **G** and **C**.
- There are **two** hydrogen bonds between A and T and **three** hydrogen bonds between G and C.
- The two chains are coiled in a right-handed fashion. The pitch of the helix is 3.4 nm (a nanometre is one billionth of a metre, that is 10^{-9} m) and there are roughly 10 bp in each turn. Consequently, the distance between two bp in a helix is approximately 0.34 nm.
- The stacking of bases creates two types of grooves — **major** and **minor grooves**.

Chargaff's Rules

- The purines and pyrimidines are always in equal amounts *i.e.*, **A + G = T + C.**
- The amount of adenine is always equal to that of thymine and the amount of guanine is always equal to that of cytosine, *i.e.*, A = T and G = C. However, amount of A + T is not necessarily equal to G + C.
- The deoxyribose sugar and phosphate components occur in equal proportions.
- The base ratio A + T / G + C may vary from one species to another, but is constant for a given species. This ratio can be used to identify the source of DNA and can help in classification.
- In human DNA, A = 30.9%, T = 29.4%, G = 19.9% and C = 19.8%.
- DNA carries all the **hereditary information** coded in the arrangement of its nitrogen bases *i.e.*, **genetic code**.

Types of DNA

- There are five types of DNA : B, Z, A, C and D. B, A (widest diameter of helix), C and D DNA are right handed helix while Z-DNA (thinnest diameter of helix) is left handed.

PACKAGING OF DNA HELIX

- Long sized DNA molecules are compacted in small areas (about 1μm in *E.coli* and 5 μm nucleus in human beings) only through packing.
- DNA is acidic due to presence of a large number of phosphate groups. Compaction occurs by folding and attachment of DNA with basic proteins, non-histone in prokaryotes and histones in eukaryotes.

DNA Packaging in Prokaryotes

- Bacterial DNA is relatively simpler in form, double-stranded molecule compacted into a structure referred to as nucleoid.
- DNA in bacterial chromosome is found to be associated with RNA and non-histone basic proteins like polyamines.

DNA Packaging in Eukaryotes

- DNA packaging in eukaryotes follow **nucleosome-solenoid model**. DNA is complexed with lysine and arginine rich basic proteins called **histones** to form **nucleosomes**.
- Each nucleosome consists of eight histone proteins (2 molecules of each H_2A, H_2B, H_3 and H_4) around which the DNA wraps 1.65 times.
- Histone H_1, is a linker protein which binds DNA of two adjacent nucleosomes.
- 10 nm fibre of nucleosomes gets coiled upon itself to form 30 nm wide helix with five or six nucleosomes per helix. This 30 nm structure is called a **solenoid**. The packing of DNA has the 'beads on a string' appearance.
- Solenoid further condenses to form loops averaging 300 nm in length.
- The 300 nm **chromatin fibres** are compressed and folded to produce a 700 nm wide **chromatid** fibre of a chromosome.
- Two types of chromatin material form chromosomes — (i) **euchromatin**, that is loosely packed and lightly stained and transcriptionally active; (ii) **heterochromatin**, that is densely packed, darkly stained and transcriptionally inactive.

EVIDENCES FAVOURING DNA AS GENETIC MATERIAL

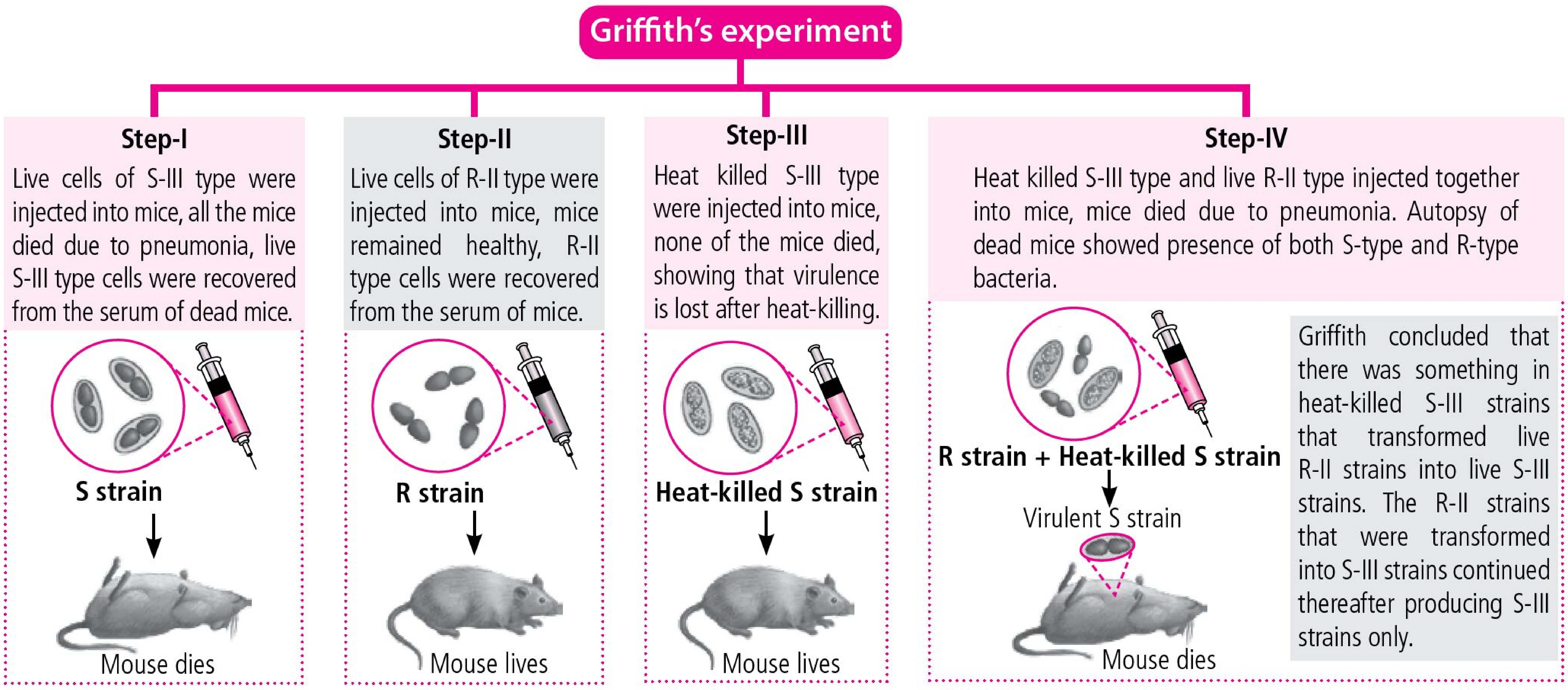
- The concept of DNA as the genetic material of most organisms has been developed and supported by following direct and indirect evidences.

Direct Evidences

- The most convincing evidences in support of DNA as the genetic material came from the three approaches on microorganisms – **transformation in bacteria**, **mode of infection of bacteriophages** (transduction) and **conjugation in bacteria**.

(i) Transformation - The Griffith's experiment

- Transformation is the mode of exchange or transfer of genetic information from one strain of bacterium to another strain of bacterium without involving any direct contact between them.
- Griffith found that extracts of dead pathogenic strains of the bacterium *Streptococcus pneumoniae* can transform live harmless strains into live pathogenic strains. Later, Avery, MacLeod and McCarty analysed the extract and demonstrated that the material was DNA.
- The bacterium has two strains — **virulent** (S-strain) and **non-virulent** (R-strain).
- **S-strain :** They form smooth glistening colonies. They have a smooth, gummy polysaccharide coating so they are **capsulated**. This coating protects the bacteria from the host's defenses. Virulent or pathogenic, *i.e.*, has the disease producing capacity.
- **R-strain :** They form rough colonies with dull appearance. They do not have the polysaccharide coating so they are **non-capsulated.** Non-virulent or non pathogenic, *i.e.*, could not cause disease.



Step-I: Live cells of S-III type were injected into mice, all the mice died due to pneumonia, live S-III type cells were recovered from the serum of dead mice.

Step-II: Live cells of R-II type were injected into mice, mice remained healthy, R-II type cells were recovered from the serum of mice.

Step-III: Heat killed S-III type were injected into mice, none of the mice died, showing that virulence is lost after heat-killing.

Step-IV: Heat killed S-III type and live R-II type injected together into mice, mice died due to pneumonia. Autopsy of dead mice showed presence of both S-type and R-type bacteria.

Griffith concluded that there was something in heat-killed S-III strains that transformed live R-II strains into live S-III strains. The R-II strains that were transformed into S-III strains continued thereafter producing S-III strains only.

Fig. : Griffith's experiment on transformation in *Streptococcus pneumoniae*

(ii) The Avery, MacLeod and McCarty experiment

- Three scientists Avery, MacLeod and McCarty gave biochemical characterisation of transforming principle. They fractionated the killed S-type bacteria into three components-DNA, carbohydrate and protein and performed the following experiment :

  (i) Removed the polysaccharide capsule from heat killed S-III type and R-II type → Mice died

  (ii) Removed protein fraction from heat killed S-III type + R-II type → Mice died

  (iii) Added deoxyribonuclease enzyme into heat killed S-III type + R-II type → Mice survived

  (iv) Added proteases into heat killed S-III type + R-II type → Mice died

- In experiments (i), (ii) and (iv), DNA of heat killed S-III type was intact and so it transformed live R-II type into S-III types, but in experiment (iii) the enzyme disintegrated the DNA and so R-II type were not transformed.
- It clearly showed that the DNA component of heat killed S-III type transformed live R-II type into live S-III type and thus, DNA forms molecular basis of heredity.

(iii) Transduction - The Hershey-Chase experiment

- It is the process in which bacterium infecting virus (bacteriophage) serves as a vector transferring DNA from one bacterium cell to another, *e.g.*, T_2 bacteriophage. **Alfred Hershey** and **Martha Chase** performed an experiment to confirm that DNA of **bacteriophage** (virus infecting bacteria) enters into host (bacterial) cell and carries the necessary information for formation of new phages. Their experiment was based on the fact that DNA contains phosphorus but no sulphur whereas proteins contain sulphur but no phosphorus.

Hershey and Chase's Experimental Steps

- **Step-I :** T_2 bacteriophages are labelled with radioactive isotopes. Protein coats of phages are labelled with ^{35}S and DNA of phages are labelled with ^{32}P.

- **Step-II :** Two cultures of *E.coli* were grown. Bacteriophages infect bacterial cells. In culture, infected with radioactive ^{35}S, radioactive sulphur gets incorporated into sulphur containing amino acids and becomes part of bacterial proteins. In culture, infected with radioactive ^{32}P, radioactive phosphorus gets incorporated into nucleotides.
- **Step-III :** Bacterial cells are agitated to remove protein coats and centrifuged. ^{35}S radioactivity was found in the supernatant, which contain only empty phage capsids or ghosts. ^{32}P radioactivity was found in the bacterial cells, proving only DNA of the phage entered the bacteria.
- Radioactivity was absent in the viruses derived from parents having labelled protein. The viruses derived from parents having labelled DNA possessed radioactivity. This experiment demonstrated clearly that genetic material is DNA and not the protein.

Indirect Evidences

(i) DNA is capable of controlling the cell structure and cell functions through transcription and translation.

(ii) DNA replicates prior to cell division and is equitably distributed in the daughter cells.

(iii) DNA has a system of repair.

(iv) DNA is capable of replication. DNA copies are similar to the original DNA.

(v) DNA can show infinite variations due to changes in its nucleotide type, sequence and length.

DNA Versus RNA

- The 2′-OH group present at every nucleotide in RNA is a reactive group and makes RNA labile and easily degradable. RNA is also now known to be catalytic, hence reactive. Therefore, DNA chemically is less reactive and structurally more stable when compared to RNA. Hence, among the two nucleic acids, DNA is a better genetic material.
- The presence of thymine at the place of uracil also confers additional stability to DNA. Both DNA and RNA are able to mutate. In fact, RNA being unstable, mutate at a faster rate. Consequently, viruses having RNA genome and having shorter life span mutate and evolve faster. RNA can directly code for the synthesis of proteins, hence can easily express the characters. DNA, however, is dependent on RNA for synthesis of proteins. The protein synthesising machinery has evolved around RNA.

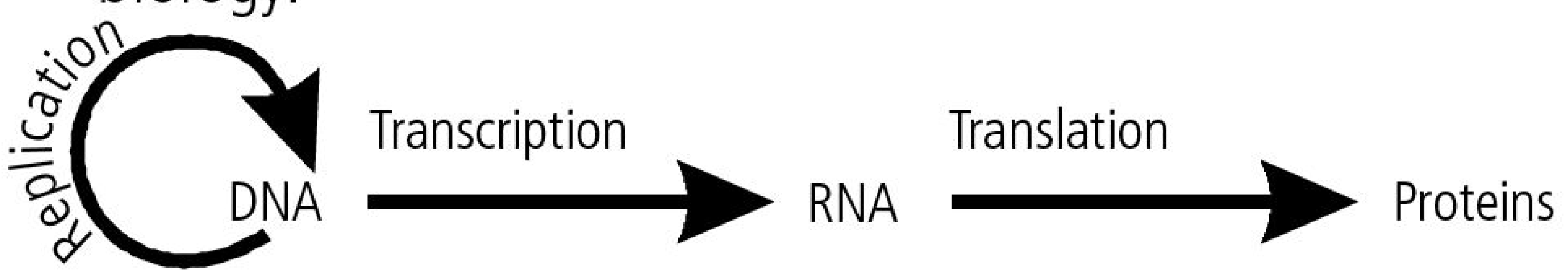
WHO AM I ...

"I am a protein helps in synthesis of DNA from RNA is found in several viruses containing RNA as genetic material."

...search me ☺

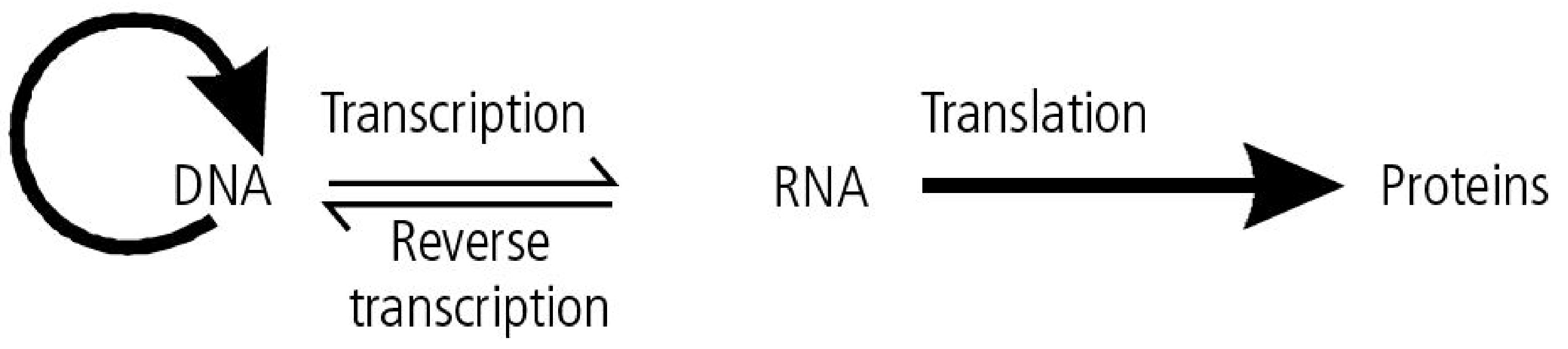
CENTRAL DOGMA OF MOLECULAR BIOLOGY

- **Crick (1958)** proposed the central dogma of molecular biology.



One way flow of information (central dogma)

- Central dogma says there is the unidirectional flow of information from DNA to RNA and from RNA to polypeptide.
- Many tumor viruses contain RNA as genetic material and replicate by first synthesising a complementary DNA. This process is called **reverse transcription**.
- It is carried out by an RNA-dependent DNA polymerase called **reverse transcriptase**. RNA of these viruses first synthesises DNA through reverse transcription. Now, DNA transfers information to RNA which takes part in translation of coded information to form polypeptide.



Reverse flow of information

DNA REPLICATION

- In replication, DNA acts as its own template and produce exact copies of itself which is an autocatalytic function of DNA.
- DNA replicates by **semiconservative** method in which one strand of the daughter duplex is derived from the parent while the other strand is newly formed.
- Semiconservative replication of DNA was proved by the work of **Meselson** and **Stahl**. In their experiment, *E.coli* was grown in ^{15}N medium having heavy isotope of nitrogen, for many generations. After that the labelled bacteria was transferred to fresh ^{14}N medium and they were allowed to grow in that medium. DNA samples were tested for heavy isotope of nitrogen.
- DNA from bacteria that had been grown on medium with ^{15}N, contained only ^{15}N isotope. DNA of the first generation, grew on ^{14}N medium, was hybrid or intermediate (^{15}N and ^{14}N). The second generation

of bacteria after 40 minutes contained two types of DNA, 50% light ($^{14}N^{14}N$) and 50% intermediate ($^{15}N^{14}N$). It proved the DNA replication in *E.coli* is semiconservative.

- Very similar experiments involving use of radioactive thymidine to detect distribution of newly synthesised DNA in the chromosomes was performed on *Vicia faba* by Taylor and colleagues in 1958. They proved that the DNA in chromosomes also replicate semi-conservatively.

Steps of DNA Replication

- Replication originated from the **origin of replication**.
- Enzyme helicase unwinds the parental double helix.
- Molecules of single strand binding protein stabilise the unwound template strands.
- Topoisomerase releases tension of DNA strand.
- For long DNA molecules, since the two strands of DNA cannot be separated in its entire length, the replication occur within a small opening of the DNA helix, referred to as replication fork.
- Replication over the two templates proceeds in opposite directions.
- DNA dependent DNA polymerase uses a DNA template to catalyse the polymerisation of deoxynucleotides. These enzymes are highly efficient enzymes as they have to catalyse polymerisation of a large number of nucleotides in a very short time. *E. coli* that has only 4.6×10^6 bp (compare it with human whose diploid content is 6.6×10^9 bp), completes the process of replication within 18 minutes; that means the average rate of polymerisation has to be approximately 2000 bp per second. Any mistake during replication would result into mutations that leads to DNA damage.
- One strand with polarity 3′ → 5′ forms its complementary strand continuously because 3′ end of the latter nucleotide is always open for elongation. It is called **leading strand**.
- Replication is discontinuous on the other template with polarity 5′ → 3′ because only a short segment of DNA strand can be built in 5′ → 3′ direction due to exposure of a small stretch of template at one time. Short segments of replicated DNA are called **Okazaki fragments**.
- RNA primer is also required every time a new Okazaki fragment is to be built. Okazaki fragments are joined together by means of enzyme DNA ligase. DNA strand built up of Okazaki fragments is called **lagging strand**.

Proofreading and DNA repair

- **DNA polymerase III** sense a wrong base introduced during replication. It goes back, removes the wrong base, allows addition of proper base and then proceeds forward.
- There is a separate repair mechanism for any damage caused to DNA due to mutation, UV exposure or mismatching that escapes proof-reading mechanism.
- A nick or break is caused by an endonuclease near the region of repair. **DNA polymerase I** removes the mismatched or wrong nucleotides if present and synthesises a correct replacement by using the intact strand as template. The newly formed segment is sealed by **DNA ligase**.

INTEXT PRACTICE QUESTIONS

1. **In Griffith's transformation experiment injection of which bacterial strain resulted in death of mice?**
2. **Who proved semi-conservative nature of DNA replication? Name the medium used in experiment.**
3. **Name the histone proteins that form core of nucleosome.**

One gene-one enzyme hypothesis given by **Beadle and Tatum** states that a gene controls a structural or functional trait through controlling the synthesis of a specific protein or enzyme.
Later, it has been proved that a single protein may have number of polypeptides and each polypeptide is controlled by a separate gene.
As a result, one gene - one enzyme hypothesis was replaced by **one gene-one polypeptide hypothesis**.
Further, when gene was identified as a functional unit or cistron, the same was termed as **one cistron-one polypeptide hypothesis**.

TRANSCRIPTION

- The process of transferring genetic information from template strand of the DNA to RNA is called **transcription**.
- A transcription unit in DNA is defined primarily by the three regions in the DNA: (i) A promoter, (ii) The structural gene, (iii) A terminator. Cistron is a segment of DNA coding for a polypeptide, the structural gene in the transcription unit could be said as monocistronic (mostly in eukaryotes) or polycistronic (mostly in prokaryotes).
- DNA-dependent RNA polymerase catalyse the polymerisation in only one direction, *i.e.*, 5′→ 3′. The strand that has the

polarity 3′→ 5′ acts as a template and is referred to as template strand. The other strand which has the polarity (5′→ 3′) and the sequence same as RNA (except thymine at the place of uracil), is displaced during transcription. Strangely, this strand (which does not code for anything) is referred to as coding strand.

Transcription in Prokaryotes

- In prokaryotes, transcription occurs in the cytoplasm with the help of DNA dependent RNA polymerase and takes place in following three steps :
  (i) **Initiation :** The σ factor (initiation factor) of RNA polymerase recognises specific DNA sequences called promoters at –35 region. RNA polymerase initiates transcription. It uses nucleoside triphosphate as substrate and polymerase in template dependent fashion following rule of complementarity and also facilitates opening of helix.
  (ii) **Elongation :** Subsequent ribonucleotide complements are inserted and linked together by phosphodiester bonds, chain elongation continues in 5′ → 3′ direction creating a temporary DNA/RNA hybrid, RNA synthesis continues till the enzyme reaches the terminator.
  (iii) **Termination :** As polymerase transcribes away from the promoter, rho factor (termination factor) binds to RNA and follows the polymerase when polymerase reaches some sort of pause site, rho factor catches up with polymerase and unwinds the DNA-RNA hybrid, resulting in release of polymerase.

Transcription in Eukaryotes

- In eukaryotes, transcription occurs within the nucleus.
- There are at least three RNA polymerases in the nucleus (in addition to the RNA polymerase found in the organelles). There is a clear cut division of labour. The RNA polymerase I transcribes *r*RNAs (28S, 18S, and 5.8S), whereas the RNA polymerase III is responsible for transcription of *t*RNA, 5SrRNA, and snRNAs (small nuclear RNAs). The RNA polymerase II transcribes precursor of mRNA, the heterogeneous nuclear RNA (hnRNA).
- Sigma factor is absent and no primer is required to start transcription. The nascent RNA synthesised by RNA polymerase II, called primary transcript, contains both unwanted and wanted base sequences. Primary transcript is converted into functional *m*RNA after post-transcription processing which involves 3 steps.

Post-transcriptional processing

(i) Initially a **cap** (consisting of 7-methyl guanosine or 7 mG) is added at the 5′ end known as **capping**. The cap is a chemically modified molecule of guanosine triphosphate.

(ii) Tail of poly A at the 3′ end is added with the help of poly A polymerase and is known as **tailing**.

(iii) **Splicing -** Removal of introns through cutting and joining of exons in defined order.

RIBONUCLEIC ACID (RNA)

- RNA is a single stranded polyribonucleotide which functions as carrier of coded genetic information from DNA to cytoplasm for taking part in protein and enzyme synthesis. In some viruses, they may appear partially double stranded due to folding or coiling of single strand. dsRNA can be seen in viruses only.
- The axis or backbone of RNA is formed of alternate residues of phosphate and ribose sugar. Phosphate combines with 5′ carbon of its sugar and 3′ carbon of next sugar similar to the arrangement found in DNA strand. Nitrogen bases are attached to sugars at 1′ carbon of the latter and are of four types — adenine (A), guanine (G), cytosine (C) and uracil (U).

Types of RNA

- There are two types of RNA :

(a) **Genetic RNA :** It takes part in genetic transmission. It is further divided into two types : double stranded (mammalian reovirus) and single stranded (TMV).

(b) **Non-genetic RNA :** It is of three types :
  (i) ***m*RNA (Messenger RNA) :** Brings coded information from DNA and takes part in its translation by bringing amino acids in a particular sequence while synthesising polypeptide.
  (ii) ***t*RNA (Transfer RNA)** - Transfers an amino acid from cytoplasm to the site of protein synthesis. It has a clover leaf shaped structure with four recognisable sites - **amino acid binding** site at 3′, **anticodon loop** (codon recognition sites), **DHU loop** (amino acid recognition site) and **T Ψ C loop** (ribosome recognition site).
  (iii) ***r*RNA (Ribosomal RNA)** - It is involved in the translation of message of DNA. *r*RNA forms the structural bench work on which a polypeptide is formed, during protein synthesis.

- **Other non-genetic RNA** : snRNA, scRNA, hnRNA and antisense RNA.

GENETIC CODE

- The genetic code is made up of **codons** through which information in RNA is decoded in a polypeptide chain. A codon is three letter sequence.
- The codons which initiate the protein synthesis are called **initiation codons**. This is **AUG** codes for Methionine (met) and act as initiator codon.
- The codons which do not code for any amino acid are called **non-sense codons** or **termination codons.** They are **UAG, UAA** and **UGA.**

Characteristics of Genetic Code

- **Universal :** A codon specifies the same amino acid in all organisms ranging from a bacterium to human beings.
- **Non-overlapping :** One letter or base cannot be used for two different adjacent codons while reading a polynucleotide chain.
- **Degenerate : 61 out of 64** codons **code for only 20 amino acids.** For a particular amino acid more than one codon can be used.
- **Non-ambiguous :** A particular codon will always code for same amino acid.
- **Triplet codon :** Three adjacent nitrogen bases constitute a codon which specifies placement of one amino acid in a polypeptide.
- **Commaless :** No punctuations are needed between any two words *i.e.*, after one amino acid is coded, the second amino acid will be automatically coded by the next three letters.

TRANSLATION (PROTEIN SYNTHESIS)

- It is the process in which the genetic information encoded in *m*RNA in the form of a sequence of nucleotide triplets is translated into a sequence of amino acids in a polypeptide chain during protein synthesis.
- Before translation can proceed, the *t*RNA molecules must be chemically linked to their respective amino acids. This activation process, called **charging**, occurs under the influence of **aminoacyl *t*RNA synthetases**. It takes place in three steps:

(i) Initiation

- The translation of *m*RNA begins with the formation of **initiation complex**. The 30S ribosomal subunit binds with two initiation factors (IF-1 and IF-3), then with the *m*RNA. The initiating codon (5′) AUG is guided to its correct position by the **Shine-Dalgarno Sequence** in the *m*RNA.
- In the second step, both GTP-bound IF-2 and the initiating fMet-*t*RNA bind with this complex.
- In third step, this large complex combines with the 50S ribosomal subunit. Simultaneously, the GTP bound to IF-2 is hydrolysed to GDP and Pi, which are released from the complex. All three initiation factors depart from the ribosome at this point.
- Functional 70S ribosome called the **initiation complex** is formed and it includes the *m*RNA and the initiating fMet-*t*RNA.

(ii) Elongation

- In the first step of the elongation cycle, the appropriate incoming aminoacyl-*t*RNA binds to a complex of **GTP-bound EF-Tu** forming a complex aminoacyl-*t*RNA–EF-Tu–GTP that binds to the **A site** of the 70S initiation complex.
- The GTP is hydrolysed and an EF-Tu–GDP complex is released from the 70S ribosome. The EF-Tu–GTP complex is regenerated in a process involving **EF-Ts** and **GTP.**
- In the next step, a **peptide bond** is formed between the two amino acids bound by their *t*RNAs to the **A** and **P sites** on the ribosome. This occurs by the transfer of the initiating N-formylmethionyl group from its *t*RNA to the amino group of the second amino acid, now in the A site.
- This reaction produces a dipeptidyl-*t*RNA in the A site and the now uncharged (deacylated) *t*RNA$_{\text{fMet}}$ remains bound to the P site. The enzymatic activity that catalyses peptide bond formation has been referred to as **peptidyl transferase.**
- In the **final step** of the elongation cycle (translocation), the ribosome moves one codon towards the 3′ end of the *m*RNA. This movement shifts the anticodon of the dipeptidyl-*t*RNA from the A site to the P site and shifts the deacylated *t*RNA from the P site to the E site, from where the **deacylated *t*RNA** is released into the **cytosol.**
- The third codon of the *m*RNA now lies in the A site and the second codon in the P site.

(iii) Termination

- Termination, is signalled by the presence of one of three **termination codons** in the *m*RNA **(UAA, UAG, UGA),** immediately following the final coded amino acid and releasing the complete polypeptide from the ribosome.

THE OPERON SYSTEM

- Operon is a part of genetic material (DNA) which acts as a single regulated unit having one or more structural genes, an **operator gene**, a **promoter gene**, a **regulator gene**, a **repressor** and an **inducer**. Operator, promoter and regulator genes constitute the regulatory region. Operon system are common in prokaryotes. Operons are of two types : inducible and repressible.

CROSS WORD

ANSWER

JUNE 2025

Contributed by : Rachit Singh, Uttar Pradesh

ACROSS

3. Vacuole
8. Lysosomes
10. Polysome
11. Tissue
13. Mitochondria
14. Cytoskeleton
15. Chloroplast
16. Nucleus
19. Fimbriae
20. Elaioplast

DOWN

1. Golgi apparatus
2. Filament
4. Ribosome
5. Diffusion
6. Cell membrane
7. Osmosis
9. Centrosome
12. Pili
17. Mesosome
18. Plastids

Table : **Differences among regulator, operator, promoter and structural genes**

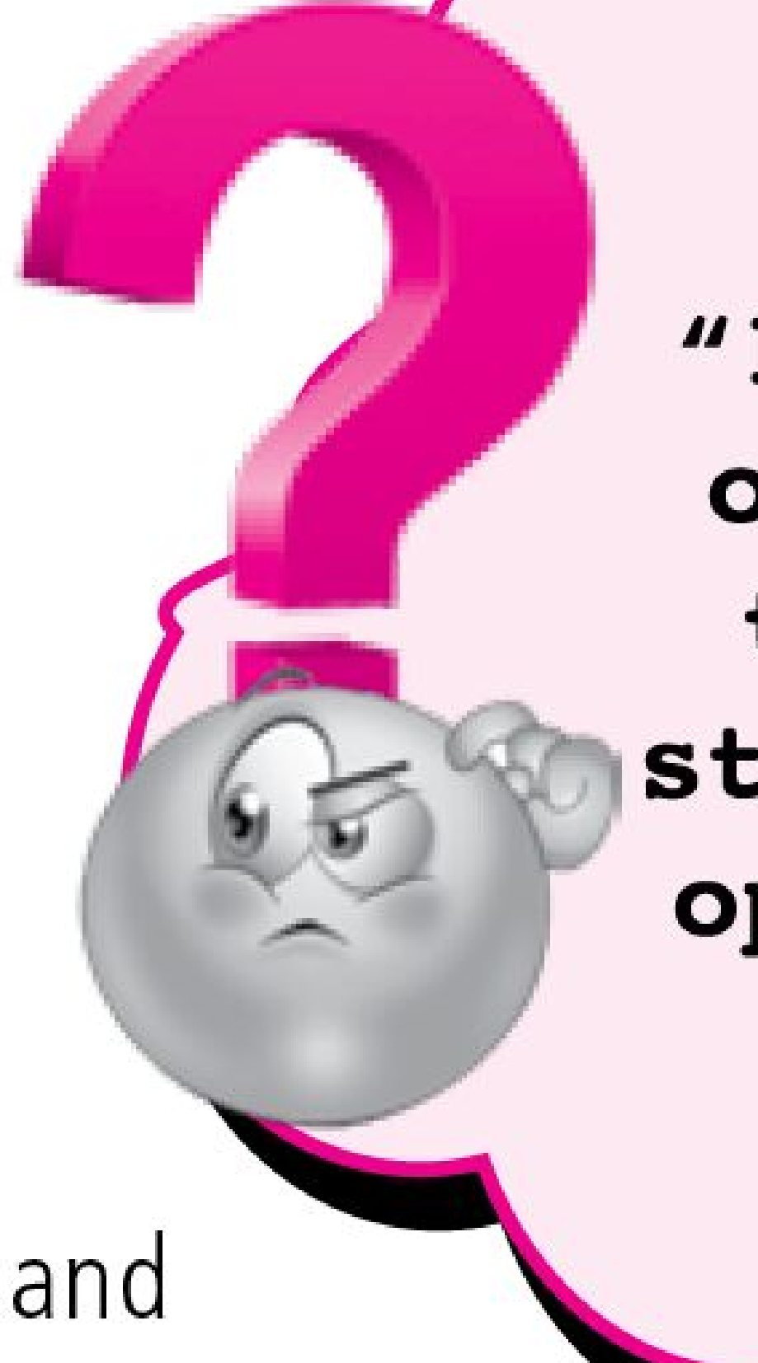
	Regulator Gene	Operator Gene	Promoter Gene	Structural Gene
(i)	It controls the functioning of operator gene.	It determines the functioning of structural genes.	It is site for binding of RNA polymerase.	The gene is connected with transcription or formation of *m*RNA for synthesis of particular polypeptide.
(ii)	This produces a repressor or aporepressor for blocking operator gene.	This gene functions only when it is not blocked by repressor.	It is functional only when operator gene allows passage of RNA-polymerase to structural genes.	It functions only when it receives complementary nucleotides and RNA polymerase.
(iii)	It is commonly a large gene.	The gene is small.	The gene is small.	The gene is moderately long to large depending upon the polypeptide to be synthesised.
(iv)	It functions through the formation of an *m*RNA of repressor.	It functions through the presence or absence of repressor.	It functions by providing recognition and binding sites for RNA polymerase.	It functions through the formation of *m*RNA for structural or enzymatic polypeptide.

(i) Inducible Operon

- An inducible operon system is a regulated unit of genetic material which is switched on in response to the presence of an inducer. It is usually found in catabolic pathways.
- The lac **operon** consists of the regulator (I), promoter (P), operator (O) sites and structural genes (*lac z*, *y* and *a*) that code for the protein (enzymes).
- In **absence of lactose**, the regulator protein (repressor) binds to the operator and **inhibits transcription**.
- **When lactose is present**, some of it is converted into allolactose. The inducer, allolactose binds to the repressor protein, the inactivated repressor can no longer block transcription. The structural genes are transcribed, ultimately resulting in the production of the enzymes (β-**galactosidase**, **permease** and **transacetylase**) needed for lactose catabolism.

(ii) Repressible Operon

- Repression is blocking of the operator gene of operon through a complex repressor that is formed by union of aporepresssor formed by regulator gene and corepressor, a product of anabolic pathway.
- **Tryptophan** (*trp*) **operon** consists of regulator (R), promoter (P), operator (O) and structural (*trp* - E, D, C, B, A) genes.
- In **absence of corepressor**, the repressor become inactive, the structural genes are transcribed and tryptophan is produced ultimately.
- In **presence of corepressor**, repressor becomes activated which binds to the operator and blocks the same thus, the structural genes stop transcription. This is called **feedback repressor** and it also exerts **negative control**.



WHO AM I ...

"I am a converted form of lactose to promote the transcription of structural genes in *lac* operon when lactose is present."

...search me ☺

HUMAN GENOME PROJECT (HGP)

- It is called **International Human Genome Sequencing Consortium** and is aimed at finding out all the genes in each of the human chromosomes determining their function and hopefully understanding how they together form the complete organism.
- The HGP was a 13-year project coordinated by the U.S. Department of Energy and the National Institute of Health. Human Genome Project was closely associated with the rapid development of a new area in biology called **bioinformatics**.
- The two factors that made this possible are : (i) Genetic engineering techniques, which made it possible to isolate and clone any segment of DNA, (ii) Availability of simple and fast techniques, for determining the DNA sequences.
- The goals of the human genome project are as follows : (i) To develop a genetic linkage map of human genome by identifying thousands of genetic markers and mapping them in the genome. (ii) To obtain a physical map of human genome by cloning genomic DNA into YACs and cosmids. (iii) To sequence the entire human genome.
- **Duchenne Muscular Dystrophy** on X chromosome is the largest gene and **TDF (Testis Determining Factor)** is the smallest gene.

Methodologies

- Expressed Sequence Tags (ESTs, *i.e.*, Focused on identifying all the genes that are expressed as RNA) and Sequence Annotation. Sequence the whole set of genome, that included all the coding and non-coding sequences and later assigning functions to different regions in the sequences are the methods used to sequence human genome.

- The commonly used hosts were bacteria and yeast, and the vectors were called as BAC (Bacterial Artificial Chromosomes) and YAC (Yeast Artificial Chromosomes).
- The fragments were sequenced using automated DNA sequencers that worked on the principle of a method developed by Frederick Sanger.
- The sequence of chromosome 1 was completed only in May 2006 which was the last of the 24 human chromosomes.

SALIENT FEATURES OF HGP

- Some of the salient observations drawn from human genome project are as follows:
  - (i) The human genome contains 3164.7 million nucleotide bases pairs.
  - (ii) The average gene consists of 3000 bases, but sizes vary greatly, with the largest known human gene being dystrophin at 2.4 million bases.
  - (iii) The total number of genes is estimated at 30,000. Almost all (99.9 per cent) nucleotide bases are exactly the same in all people.
  - (iv) The functions of over 50 per cent of the discovered genes are unknown.
  - (v) Less than 2 per cent of the genome codes for proteins.
  - (vi) Repeated sequences (stretches of DNA sequences that are repeated many times, sometimes hundred to thousand times) make up very large portion of the human genome.
  - (vii) Chromosome 1 has most genes (2968) and the Y has the fewest (231).
  - (viii) Scientists have identified about 1.4 million locations where single base DNA differences (SNPs – **single nucleotide polymorphism**, pronounced as 'snips') occur in humans.

DNA FINGERPRINTING

- DNA fingerprinting is a technique of determining certain nucleotide sequences, generally repeated sequences (Satellite DNA) in the human genome that produce a pattern of bands which is unique for every individual. The basis of DNA fingerprinting are short nucleotide repeats in DNA called the **Variable Number of Tandem Repeats** or **VNTRs** that vary in number from person to person, but are inherited.
- The technique of DNA fingerprinting was initially developed by Alec Jeffreys.

Technique for DNA Fingerprinting

- DNA fingerprints can be prepared from extremely minute amounts of blood, semen, hair bulb or any other cells of the body. The major steps are as follows :
  - DNA is extracted from the cells in high-speed refrigerated centrifuge.
  - DNA molecules are broken with help of enzyme restriction endonuclease that cut them into fragments.
  - These DNA fragments are separated through **gel electrophoresis**. The separated fragments can be visualised by staining them with a dye that fluoresces under ultraviolet radiation.
  - Double-stranded DNA, is then split into single-stranded DNA using alkaline chemicals. Separated DNA sequences are transferred from gel onto a nitrocellulose or nylon membrane (**Southern blotting**).
  - The nylon sheet is then exposed to probes or markers that are radioactive, synthetic DNA segments and complementary to known sequences. The probes target a specific nucleotide sequence, which is complementary to VNTR sequences and hybridise them.
  - Lastly, X-ray film is exposed to the nylon sheet containing radioactive probes. Dark bands develop at the probe bound DNA sites. Thus, hybridised fragments are detected by **autoradiography** and the film developed represents **DNA fingerprint**.

Applications of DNA Fingerprinting

- For identifying the true (biological) father/mother, DNA samples of the child, mother and father are taken. The bands of child's DNA should match the DNA prints of the biological parents.
- DNA fingerprints of suspects from blood or hair or semen picked up from the scene of crime are prepared and compared. The DNA fingerprint of the person matching the one obtained from sample obtained from the scene of crime can give a clue to the actual criminal.
- It is used to determine and study human lineages.
- It can be used to identify genes associated with hereditary disorders.
- It is useful in determining population and genetic diversities.

INTEXT PRACTICE QUESTIONS

4. By which technique are hybridised DNA fragments visualised in DNA fingerprinting?

5. Name the factor which identifies promoter region in DNA for initiating transcription.

☺☺

Mind Boggling Facts

- When we shiver in the cold, our body releases the exercise hormone irisin, which encourages our body to turn fat into heat.
- An ant, in general, is capable of lifting 10 to 50 times its own weight. True inspiration!
- The mantis shrimp has the most complex eye in the animal kingdom, with 12 colour receptors. For comparison, humans possess only 3. This means that the mantis shrimp can see colours which humans cannot even perceive. Although their ability to discriminate between colours is limited.
- All babies just after birth see only black and white. Colour vision starts to develop in weeks after birth and infants are able to fully perceive colour by 6 months.
- Entire eye transplantation is currently impossible with present medical knowledge and practices. Only the cornea can be transplanted successfully.
- Snakes use its forked tongue to smell and identify chemical traces of its prey from the environment.
- Octopuses have very good camouflage – they can change their body colour to match their surroundings just in milliseconds.
- The water animal Hydra never gets old and can live forever. They are known for their regeneration capabilities.
- Dolphins and whales don't drink water. They produce it internally by metabolic breakdown of food.
- Corneas are the only living tissues that don't require blood.
- If you fully stretch your arms out, the fingertip to fingertip length is almost very close to your body height.
- The nerves in our body are most concentrated in our fingertips. Fingertips contain a high density of several specialised nerve endings.
- Turtles and sea cucumbers can breathe through their anus by pulling in water with dissolved oxygen.
- Honeybees have remained unchanged in form or structure for 20 million years.
- Elephants can hear through their feet. They actually perceive vibrations through their feet.
- The indentation in the middle of the area between the nose and the upper lip has a name called philtrum.
- Crickets have ears on their front legs. Located just below the knees, their ears are among the smallest in the animal kingdom.
- Baby cobra venom is just as potent as an adult cobra's venom. Their bite is dangerous because cobras can inject large amounts of venom in a single bite. Cobra venom contains a neurotoxin that affects the central nervous system and can lead to paralysis, respiratory system failure, and death.
- The pistol shrimp catches its prey by surprising it with a loud banging noise made with its claws. The sound is so loud that it stuns or even kills their prey. The sound made by pistol shrimp claws can be as loud as 210 decibels, which is louder than a gunshot.
- Frogs have ear drums on the outside of their heads. While frogs don't have an external ear as do humans, they have an inner ear, middle ear, and an outer ear drum or tympanum.
- Magnetoreception is like magnetic compass present in some migratory birds that help them navigate using the Earth's magnetic field.
- Armadillos spend about 80% of their life asleep.

☺☺

Check Your Vitals for NEET

CLASS XII

Maximise your chance of success in medical entrance exams by reading this article. This section is specially designed to optimise your preparation by practising more and more. It is a unitwise series having chapterwise question bank, allowing you to prepare systematically and become more competent.

- Recall question or single concept question – indicated by a single finger.
- Application question or question which requires 2 concepts - indicated by 2 fingers.
- Application question or question which requires 3 or more concepts - indicated by 3 fingers.

UNIT-VII : GENETICS AND EVOLUTION

CHAPTER-4 : PRINCIPLES OF INHERITANCE AND VARIATION

Multiple Choice Questions

1. In the cross YYRR × yyrr, the ratio of green coloured seeds in F_2 generation is
(a) 8/16 (b) 6/16 (c) 4/16 (d) 2/16.

2. Select the incorrect statement regarding linkage.
(a) Complete linkage produces many parental types and a few recombinants in progeny.
(b) Crossing over is rare between linked genes.
(c) Incompletely linked genes are located very closely in the same chromosome and are inherited together over the generations.
(d) Completely linked genes do not segregate independently.

3. A gene that influences more than one character is
(a) polygene (b) pleiotropic gene
(c) duplicate gene (d) epistatic gene.

4. Multiple phenotype is seen in
(a) dominance relationship
(b) particulate inheritance
(c) monogenic inheritance
(d) polygenic inheritance.

5. An organism with two identical alleles is
(a) dominant (b) hemizygous
(c) heterozygous (d) homozygous.

6. What will be the percentage of pure breeding F_2 individuals of a monohybrid cross?
(a) 25% (b) 50% (c) 75% (d) 40%

7. Which of the following pair of features is a good example of polygenic inheritance?
(a) Human height and skin colour.
(b) ABO blood group in humans and flower colour of *Antirrhinum.*
(c) Hair pigment of mouse and tongue rolling in humans.
(d) Human hair colour and sickle cell anaemia.

8. Which one of the following symbols and its representation, used in human pedigree analysis is correct?
(a) ○ = Unaffected male
(b) □ = Unaffected female
(c) ◆ = Affected male
(d) □═○ = Mating between relatives

9. Select the correct match.
(a) Haemophilia – Y linked
(b) Phenylketonuria – Autosomal dominant trait
(c) Sickle cell anaemia – Autosomal recessive trait
(d) Thalassemia – X linked

10. A mutation is a
(a) sudden temporary change in an organism's genetic material
(b) spontaneous change that occurs in response to specific external factors and chemicals
(c) change in hereditary material directed by a changing environment
(d) change in genotype which may result in a new expression of a characteristic.

11. Inheritance of skin colour in humans is an example of
(a) point mutation (b) polygenic inheritance
(c) codominance (d) chromosomal aberration.

12. Which statement is incorrect for polygenic inheritance?
(a) Polygenic traits are controlled by three or more genes.
(b) Environment has lesser effect on phenotypic expression.
(c) It control quantitative traits.
(d) Both (b) and (c)

13. Which of the following statements is not true for two genes that show 50% recombination frequency?
(a) The genes are tightly linked.
(b) The genes show independent assortment.
(c) The genes may be on different chromosomes.
(d) All of these

14. Inheritance of ABO blood groups is an example of
(i) incomplete dominance
(ii) dominance
(iii) codominance
(iv) multiple allelism
(a) (i) and (iii) only (b) (ii) and (iii) only
(c) (ii), (iii) and (iv) (d) (i), (iii) and (iv)

15. Select the pair of dominant traits studied by Mendel.
(a) Axial flower, green pod, green seed
(b) Green pod, inflated pod, axial flower
(c) Yellow seed, violet flower, yellow pod
(d) Round seed, constricted pod, axial flower

Match The Columns

16. Match column I with column II.

	Column I		Column II
A.	Dihybrid test cross	(i)	9 : 3 : 3 : 1
B.	Law of segregation	(ii)	Multiple allelism
C.	Law of independent assortment	(iii)	1 : 1 : 1 : 1
D.	ABO blood group in man	(iv)	Purity of gametes

17. Match Column I with Column II. (There can be more than one match for items in Column I).

	Column I		Column II
A.	Down's syndrome	(i)	Sterile females
B.	Turner's syndrome	(ii)	Skin pigmentation
C.	Phenylketonuria	(iii)	Chromosome 11
D.	Thalassemia	(iv)	Phenylpyruvic acid
E.	Sickle-cell anaemia	(v)	Glutamic acid
		(vi)	Short statured
		(vii)	Round face
		(viii)	Biconcave disc

Passage Based Questions

18. **(A)** Complete the given passage with appropriate words or phrases.

Thalassemia is an autosome-linked recessive blood disease transmitted from parents to the offspring when both the partners are (i) carrier for the gene. The defect could be due to either (ii) or deletion which ultimately results in reduced rate of synthesis of one of the globin chains (α and β chains) that make up (iii). This causes the formation of abnormal haemoglobin molecules resulting into (iv) which is characteristic of the disease. Thalassemia can be classified according to which chain of the haemoglobin molecule is affected. In α Thalassemia, production of α globin chain is affected while in β Thalassemia, production of β globin chain is affected. α Thalassemia is controlled by two closely linked genes (v) and (vi) on chromosome (vii) of each parent and it is observed due to mutation or deletion of one or more of the four genes. The more genes affected, the less alpha globin molecules produced. While β Thalassemia is controlled by a (viii) gene (ix) on chromosome 11 of each parent and occurs due to mutation of one or both the genes. Thalassemia differs from (x) in that the former is a quantitative problem of synthesising too few globin molecules while the latter is a qualitative problem of synthesising an incorrectly functioning globin.

(B) Read the given passage and correct the errors, wherever present.

Colour blindness is an autosome linked recessive disorder due to defect in either red or green cone of eye resulting in failure to discriminate between red and green colour. This defect is due to deletion in certain genes present on the X chromosome. It occurs in about 8 per cent of females and only about 0.4 per cent of males. This is because the genes that lead to red-green colour blindness are on the X chromosome. The son of a woman who carries the gene has a 50 per cent chance of being colour blind. The mother is not herself colour blind because the gene is dominant. That means that its effect is suppressed by her matching recessive normal gene. A daughter will not normally be colour blind, unless her mother is a carrier and her father is colour blind.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. **Assertion :** Human skin colour shows polygenic inheritance.
Reason : Skin colour in humans show pleiotropic inheritance.

20. **Assertion :** The law of independent assortment can be studied by means of dihybrid cross.
Reason : The law of independent assortment is applicable only to linked genes.

21. **Assertion :** When yellow bodied, white eyed *Drosophila* females were hybridised with brown-bodied, red eyed males and F_1 progeny was intercrossed, F_2 ratio deviated from 9 : 3 : 3 : 1.

Reason : When two genes in a dihybrid are on the same chromosome, the proportion of parental gene combinations are much higher than the non-parental type.

22. **Assertion :** ABO blood group system provides a good example of multiple alleles.
Reason : In ABO blood group system, when I^A and I^B alleles are present together, they both express their own types.

23. **Assertion :** Pairing and separation of pair of chromosomes would lead to segregation of a pair of factors they carried.
Reason : Two alleles of a gene pair are located on similar sites on non-homologous chromosomes.

24. **Assertion :** Colour Blindness is a sex-linked recessive disorder.
Reason : This defect is due to mutation in certain genes present in the X-chromosome.

25. **Assertion :** Genetic disorders may be grouped into two categories - Mendelian disorders and chromosomal disorders.
Reason : Chromosomal disorders are mainly determined by alternation or mutation in the single gene.

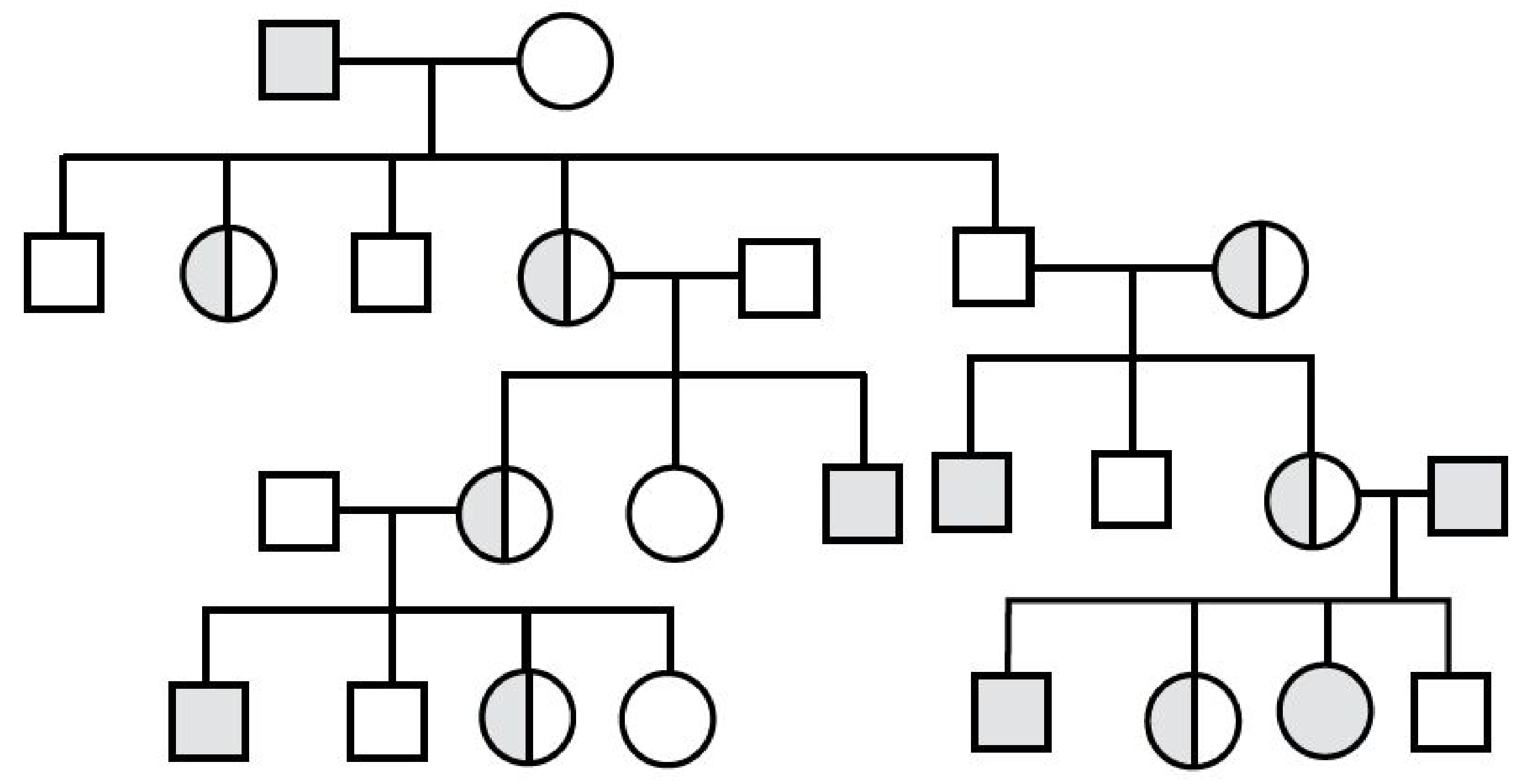
26. **Assertion :** In honeybees, drones have 16 chromosomes while queen has 32 chromosomes.
Reason : Male bees develop from unfertilised eggs and female bees from fertilised eggs.

27. **Assertion :** Sickle-cell anaemia is an autosome-linked recessive disorder that can be transmitted if both parents are heterozygous for the gene.
Reason : In sickle-cell anaemia, haemoglobin molecule undergoes polymerisation under low oxygen tension causing the change in shape of RBC.

28. **Assertion :** Turner's syndrome is caused due to absence of any one of the X and Y sex chromosome.
Reason : Turner's syndrome is an example of aneuploidy.

Figure Based Questions

29. Study the given pedigree.



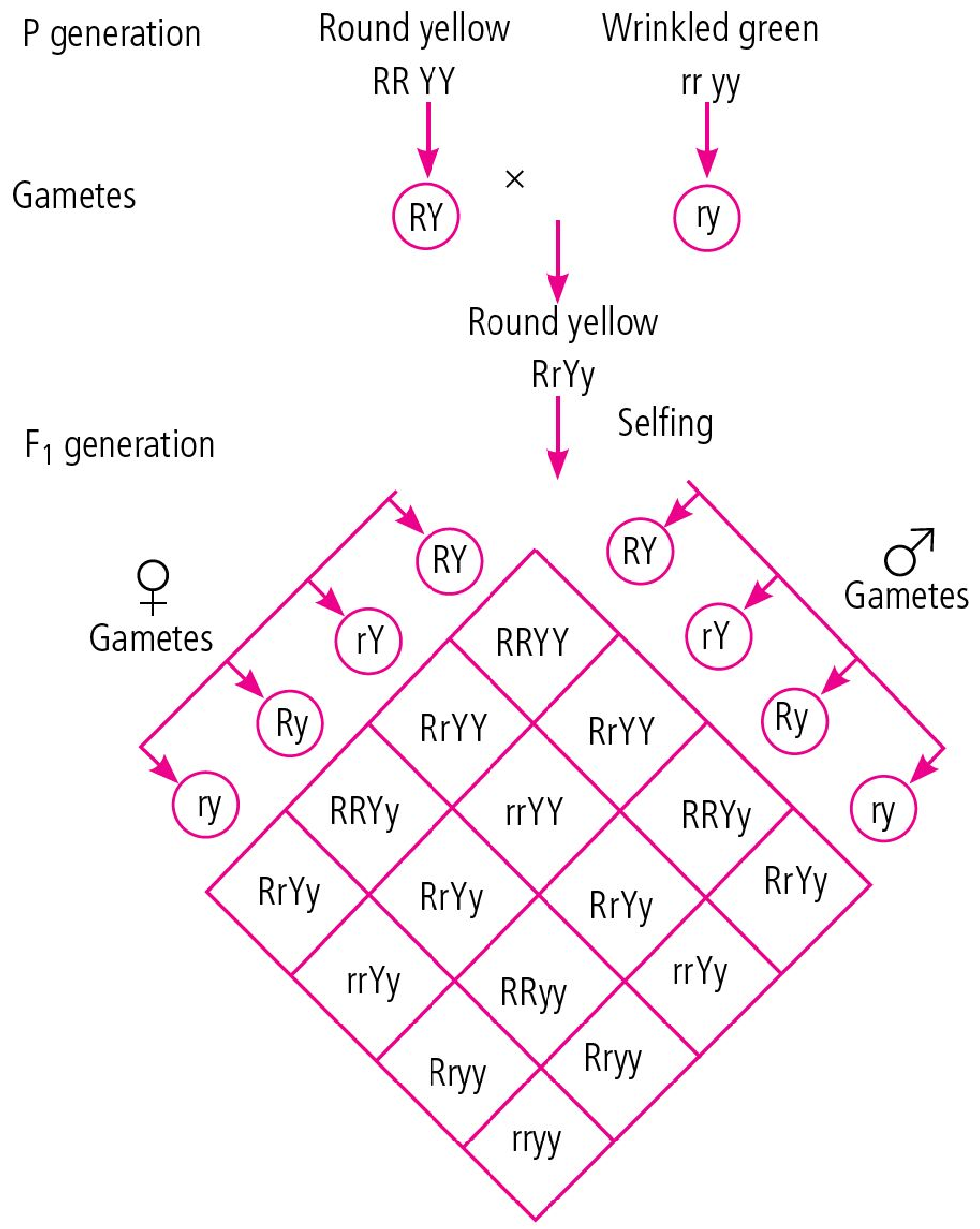
With reference to the above family pedigree answer the following questions

(a) Identify the mode of inheritance.

(b) Identify two diseases inherited through this kind of inheritance.

(c) What would be the probability of disease in F_1 if the father is suffering from the same disease and mother is carrier?

30. A scientist crosses round yellow seeded pea plant to wrinkled green seeded pea plant and observed the inheritance of both traits as per the following pattern. He collected total 1600 seeds in F_2 generation.



(a) What would be the total number of seeds heterogenous for yellow colour and homogenous for round seed shape?

(b) What phenotypic ratio would be obtained if the plants of F_1 generation would be crossed with wrinkled green seeded plant?

(c) How many seeds would be homogenous for round seed shape and green seed colour?

CHAPTER-5 : MOLECULAR BASIS OF INHERITANCE

Multiple Choice Questions

1. In a DNA molecule, complementary nucleotides are joined by
(a) hydrogen bonds
(b) glycosidic bonds
(c) ester bonds
(d) phosphodiester bonds.

2. What is correct for replication?
(a) Discontinuous and semiconservative
(b) Continuous and semiconservative
(c) Semidiscontinuous and semiconservative
(d) Conservative and semicontinuous

3. In 1953, double helical structure of DNA given by Watson and Crick was based on
(a) electron micrograph
(b) chromatography
(c) X-ray diffraction technique
(d) centrifugation.

4. Which of the following statements are correct?
(a) RNA polymerase I transcribes *r*RNAs.
(b) RNA polymerase II transcribes *sn*RNAs.
(c) RNA polymerase III transcribes *hn*RNA.
(d) RNA polymerase I transcribes *t*RNA.

5. Mode of DNA replication in *E. coli* is
(a) conservative and unidirectional
(b) semi-conservative and unidirectional
(c) conservative and bidirectional
(d) semi-conservative and bidirectional.

6. Read the following statements and choose the correct option.
I. RNA polymerase associates transiently with 'Rho' factor to initiate transcription.
II. In bacteria, transcription and translation takes place in the same compartment.
III. RNA polymerase I is responsible for transcription of *t* RNA.
IV. When hnRNA undergoes capping process, adenylate residues are added at 3′ end in a template independent manner.
V. hnRNA is the precursor of *m*RNA.
(a) III and IV only (b) II, III and V
(c) II and V only (d) I and IV only

7. Amino acid sequence, in protein synthesis is decided by the sequence of
(a) *r* RNA (b) *t* RNA
(c) *m*RNA (d) *c* DNA.

8. Choose the wrong statement.
(a) VNTR belong to a class of mini-satellite DNA.
(b) Automated DNA sequencers worked on the principle of a method developed by George Gamow.
(c) HGP was coordinated by US Department of energy and the National institute of Health.
(d) Satellite DNA normally do not code for proteins.

9. In human genome, highest and lowest number of genes are found on______ and _________ respectively.
(a) 1st chromosome, Y- chromosome
(b) 2nd chromosome, X- chromosome
(c) 21st chromosome, Y- chromosome
(d) 3rd chromosome, X- chromosome

10. Operon is
(a) a set of closely linked genes regulating a metabolic pathways in prokaryotes
(b) the sequence of three nitrogen bases determining a single amino acid
(c) the sequence of nitrogen bases in *m*RNA which codes for a single amino acid
(d) a gene responsible for switching on or off other genes.

11. Which of the following is correct regarding genetic code?
(a) UUU is the initiation codon which also codes for phenylalanine.
(b) There are 64 triplet codons and only 20 amino acids.
(c) Three random nitrogen bases specify the placement of one amino acid.
(d) UAA is the nonsense codon which also codes for methionine.

12. Some of the steps of DNA fingerprinting are given below. Identify the correct sequence from the options given.
A. Separation of DNA fragments by electrophoresis
B. Hybridisation probe using labelled VNTR
C. Digestion of DNA by restriction endonuclease
D. Autoradiography
E. Blotting of DNA fragments to nitrocellulose membrane
(a) C – A – B – E – D (b) C – A – E – B – D
(c) A – E – C – B – D (d) A – C – E – D – B

13. Read the given statements regarding DNA replication in prokaryotes and eukaryotes.
(i) In eukaryotes, replication is semi-conservative and discontinuous.
(ii) In prokaryotes, replication is semi-conservative, bidirectional.
(iii) Semi-conservative, semi-discontinuous and bidirectional replication occurs in eukaryotes.
(iv) Prokaryotes DNA replication is semi conservative, semi discontinuous and unidirectional.
Select the correct option.
(a) (i) and (iii) are correct.
(b) (ii) and (iii) are correct.
(c) (ii) and (iv) are correct.
(d) (iii) and (iv) are correct.

14. Select the incorrect match.
(a) GUG – Valine (b) AUG – Methionine
(c) UCA – Serine (d) GGU – Leucine

15. Degeneration of a genetic code is attributed to the
(a) first position of a codon
(b) second position of codon
(c) entire codon
(d) third position of a codon.

Match The Columns

16. Match column I with column II.

	Column I		Column II
A.	GGG	(i)	Proline
B.	UUU	(ii)	Glycine
C.	CCC	(iii)	Arginine
D.	AAA	(iv)	Phenylalanine
		(v)	Lysine

17. Match the column I with column II. (There can be more than one match for items in column I.)

Column I	Column II
A. DNA	(i) Repressor
B. Genetic code	(ii) Nuclein
C. RNA	(iii) Degenerate
D. *i* gene	(iv) Catalyst
	(v) Deoxyribonucleotides
	(vi) Unstable and reactive
	(vii) Regulatory gene
	(viii) Universal

Passage Based Questions

18. (A) Complete the given passage with appropriate words or phrases.

DNA fingerprinting involves identifying differences in some specific regions in DNA sequence called as (i) DNA, because in these sequences, a small stretch of DNA is repeated many times. These repetitive DNA are separated from bulk (ii) DNA as different peaks during density gradient (iii) . The bulk DNA forms a major peak and the other small peaks are referred to as (iv) DNA. Depending on base composition (A: T rich or G:C rich), length of segment, and number of repetitive units, the satellite DNA is classified into many categories, such as (v) , (vi) etc. These sequences normally do not code for any (vii) , but they form a large portion of human genome. These sequence show high degree of polymorphism and form the basis of DNA fingerprinting. Since DNA from every tissue (such as blood, hair-follicle, skin, bone, saliva, sperm etc.), from an individual show the same degree of (viii) , they become very useful identification tool in (ix) applications. Further, as the polymorphisms are (x) from parents to children, DNA fingerprinting is the basis of paternity testing, in case of disputes.

(B) Read the given passage and correct the errors, wherever present.

Translation refers to the process of polymerisation of nucleotides to form amino acids. The order and sequence of amino acids are defined by the sequence of bases in the *t*RNA. Eukaryotic translation occurs on 70S ribosomes. It is a discontinuous process as transcription occurs in cytoplasm while translation takes place in nucleus.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. Assertion : DNA fingerprinting involves identifying differences in some specific regions in DNA sequence.
Reason : In repetitive DNA sequences, a small stretch of DNA is repeated many times.

20. Assertion : In eukaryotes, replication and transcription occur in the nucleus but translation occurs in the cytoplasm.
Reason : *m*RNA is transferred from the nucleus to the cytoplasm where ribosomes and amino acids are available for protein synthesis.

21. Assertion : The genetic code is degenerate.
Reason : Some amino acids are coded by more than one codon.

22. Assertion : UAA, UAG and UGA are called termination codons.
Reason : Termination codon are recognised by protein releasing factors.

23. Assertion : RNA polymerase catalyes chain elongation of RNA.
Reason : The presence of sigma factor is required for initiation of transcription.

24. Assertion : DNA ligase joins two DNA chains.
Reason: DNA ligase catalyses the formation of phosphodiester bonds between two chains.

25. Assertion : DNA fingerprinting is very well known for its application in paternity testing in case of disputes.
Reason : DNA fingerprinting employs the principle of polymorphism in DNA sequences as the polymorphisms are inheritable from parent to children.

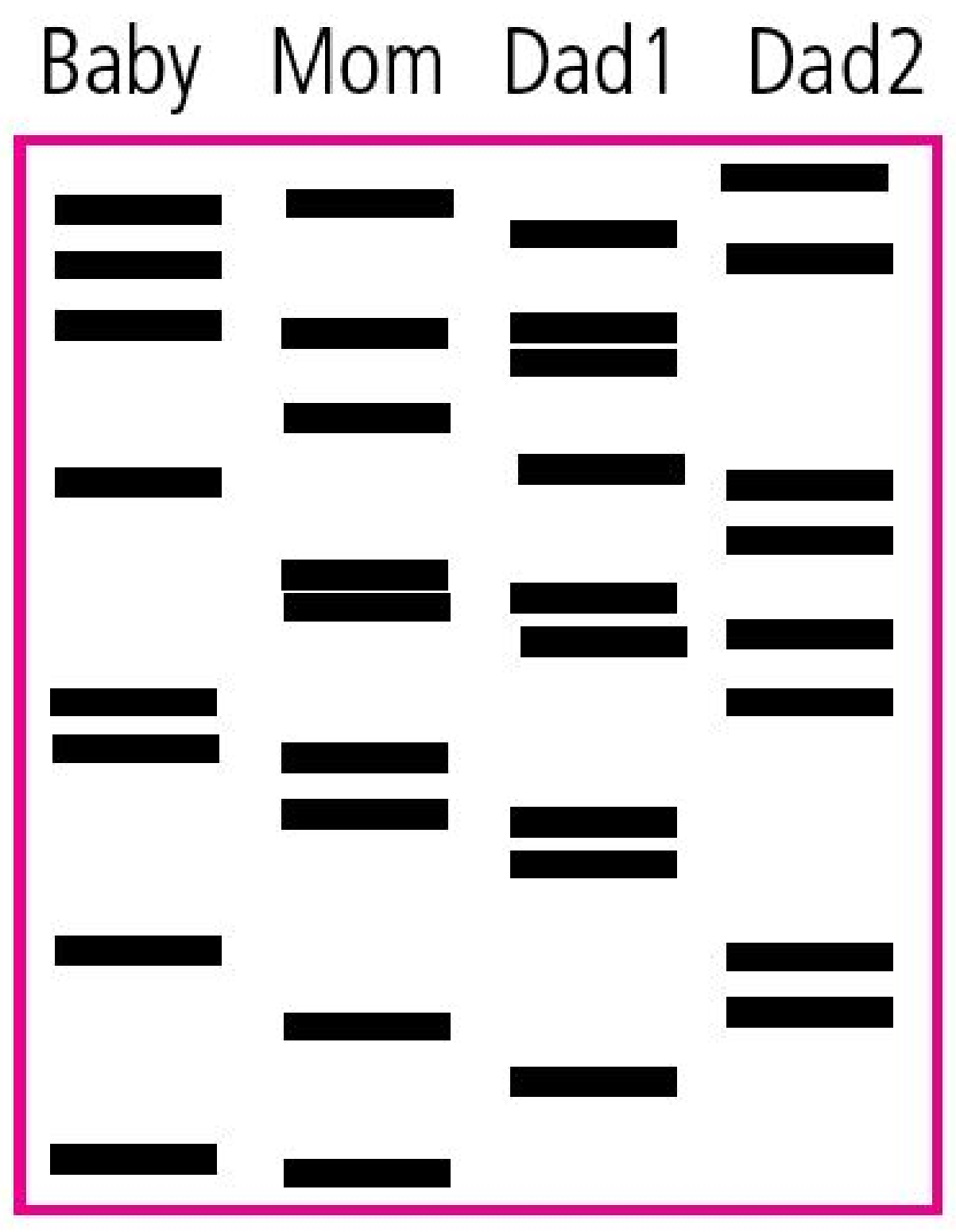
26. Assertion: Molar amount of adenine is always equal to the molar amount of guanine.
Reason: (A+T)/(G+C) ratio is constant for a species.

27. Assertion : In Griffith's experiment, a mixture of heat-killed virulent bacteria R and live non-virulent bacteria S, lead to the death of mice.
Reason : 'Transforming principle' got transferred from heat-killed S strain to R strain and made it virulent.

28. Assertion: Inducer metabolites inactivate the repressor of an operon system during induction.
Reason: Induction is the switching on of an operon which normally remains turned off.

Figure Based Questions

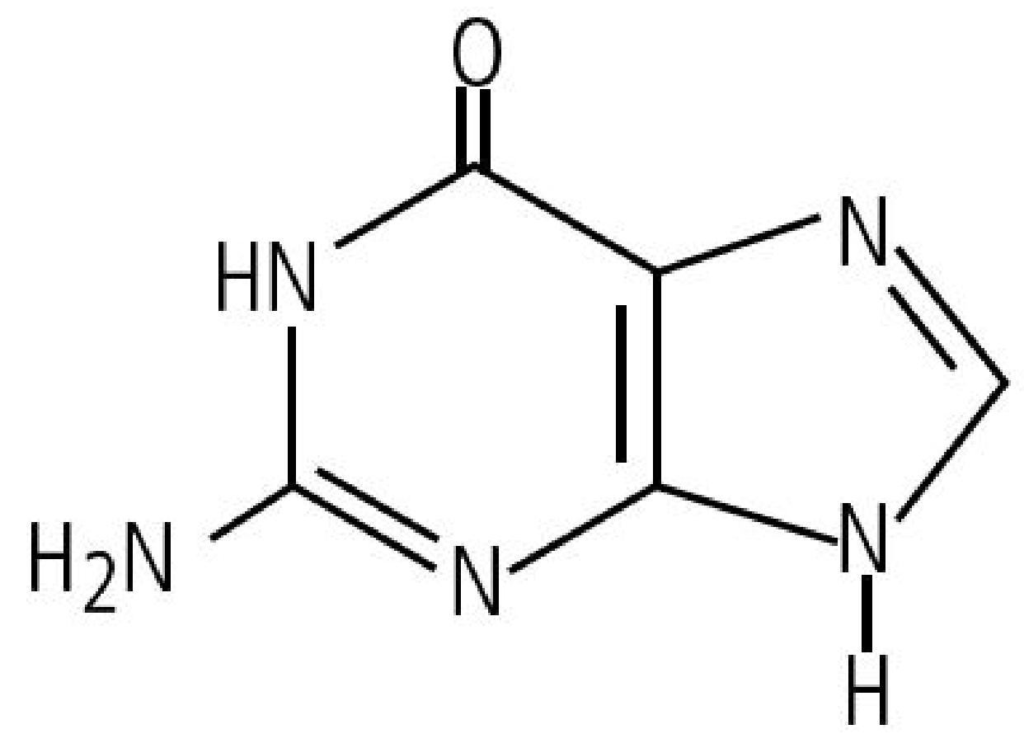
29. Study the given figure and answer the following questions.

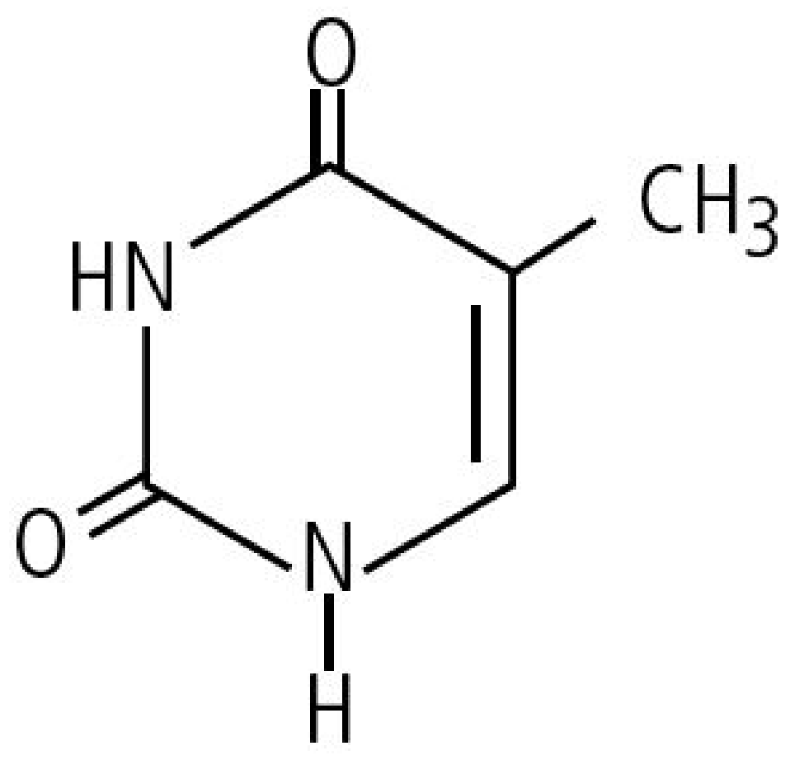


(a) Identify the process involved in the given figure.
(b) How this technique is better than other techniques in solving paternity disputes?

(c) In the given figure, which band pattern reveals the actual father of the baby?

30. Observe the given figures and answer the following question.





(a) Identify the nitrogenous bases A and B.
(b) Where are these molecules found?
(c) What are the type and number of bonds they form with other nitrogenous bases?

CHAPTER-6 : EVOLUTION

Multiple Choice Questions

1. The theory of biogenesis refers to
(a) the origin of life from non living molecules slowly
(b) the evolution of life from simple biotic life
(c) the origin of life from living molecules slowly
(d) the origin of life from non living molecules abruptly.

2. Which of the following are correctly matched?

1.	Marsupials in Australia	–	Adaptive radiation
2.	Darwin finches	–	Adaptive radiation
3.	Moth with black wing and grey wing in England	–	Artificial selection
4.	Octopus eye and mammal eye	–	Divergent evolution

(a) 1 and 3 are correct. (b) 1 and 2 are correct.
(c) 2 and 3 are correct. (d) 2 and 4 are correct.

3. Mammals like whale, dolphins, bat, monkey and horse have some common characters but they also show conspicuous differences. This is due to phenomenon of
(a) normalisation (b) genetic drift
(c) convergent evolution (d) divergent evolution.

4. Natural selection can lead to A (in which more individuals acquire mean character value), B (more individuals acquire value other than the mean character value) or C (in which more individuals acquire peripheral character value).
Choose the correct option for A, B and C to complete the given statement.
(a) A-directional change, B-stabilisation, C-disruption
(b) A-stabilisation, B-directional change, C-disruption
(c) A-stabilisation, B-disruption, C-directional change
(d) A-disruption, B-directional change, C-stabilisation

5. Which of the following statements are correct?
I. Bird originated 150 million years ago.
II. Jawless fish evolved around 350 million years ago.
III. Multicellular organisms originated 1 billion year ago.
(a) I and II only (b) II and III only
(c) I and III only (d) I, II and III.

6. Which of the following statement(s) are correct?
I. Amphibians evolved into reptiles.
II. Fish with stout and strong fins could move on land and go back to water. This was about 350 million years ago.
III. About 65 million years ago dinosaurs disappeared.
IV. *Homo habilis* was the first tool maker and used tools of chipped stones extensively.
(a) I and II only (b) III and IV only
(c) I and IV only (d) I, II, III and IV.

7. Which of the following is correct about the first mammals?
(a) They were like shrews.
(b) They were viviparous.
(c) Their fossils are small sized.
(d) All of these

8. An incorrect statement about Darwin's finches is
(a) original ground finches were seed eaters
(b) their beaks were altered to feed upon insects only
(c) alteration in beaks made the finches insectivorous and vegetarian
(d) the evolution in finches started from a point and radiated to other areas.

9. Coal has been mainly formed by
(a) bryophytes
(b) pteridophytes/pteriodosperms
(c) angiosperms
(d) algae.

10. In the case of peppered moth (*Biston betularia*), the black-coloured form became dominant over the light-coloured form in England during industrial revolution. This is due to
(a) appearance of the darker coloured individuals due to very poor sunlight
(b) protective mimicry
(c) inheritance of darker colour character acquired due to the polluted environment
(d) natural selection whereby the darker forms were selected.

11. Stabilising selection favours
(a) both extreme forms of a trait
(b) intermediate forms of a trait
(c) environmental differences
(d) one extreme form over the other extreme form and over intermediate forms of a trait.

12. Which is the correct statement regarding industrialisation in England?
(a) The white-winged moths were completely wiped out after industrialisation.
(b) Since lichens did not grow in polluted area, the number of melanised moths got reduced.
(c) After industrialisation, the count of white-winged moths became low due to predators.
(d) All of these

13. Neanderthal man
(a) resembled modern man
(b) often had a somewhat larger brain than modern man
(c) was culturally more advanced than modern man
(d) had a smaller brain than modern man.

14. Select the correct statements about genetic drift.
(i) It upsets the Hardy-Weinberg equilibrium.
(ii) Founder's effect is an important example of genetic drift.
(iii) It occurs by chance.
(iv) The original drifted population members are called founders.
(a) (i), (ii) and (iii) only (b) (i), (ii) and (iv) only
(c) (ii), (iii) and (iv) only (d) (i), (ii), (iii) and (iv)

15. Consider a population with a total of 500 alleles for a specific gene. How many individuals are in this population?
(a) 1000 (b) 500
(c) 250 (d) 125

Match The Columns

16. Match column I with column II.

	Column I		**Column II**
A.	Mutation	(i)	Random change in population's allele frequencies
B.	Gene flow	(ii)	Differences in survival and reproduction among variant individuals
C.	Natural selection	(iii)	Change in allele frequencies
D.	Genetic drift	(iv)	Source of new alleles

17. Match the column I with column II. (There can be more than one match for items in column I.)

	Column I		**Column II**
(A)	Mole	(i)	Tasmanian tiger cat
(B)	Anteater	(ii)	Flying phalanger
(C)	Lemur	(iii)	Marsupial mole
(D)	Flying squirrel	(iv)	Numbat
		(v)	Spotted cuscus
		(vi)	Tasmanian wolf
		(vii)	Marsupial mouse

Passage Based Questions

18. **(A)** Complete the given passage with appropriate words or phrases.

The process by which the organisms that appear physically, physiologically and behaviorally better adapted to the environment, survive and reproduce is called (i). This process depends upon the existence of (ii) variation within the population. In (iii) selection, average sized individuals are favoured over small sized ones, reduces (iv) and thus evolutionary change does not occur. Graphical curve obtained from such population is (v). During progressive selection, the (vi) size of population changes. (vii) selection favours both small and large sized individuals. It produces two peaks in distribution of traits, leading to development of different (viii). Disruptive selection is rare in nature but plays an important role in (ix). Evolution of DDT resistant mosquitoes is an example of (x) selection.

(B) Read the given passage and correct the errors, wherever present.

Each gorilla somatic cell contains 46 chromosomes. Out of these chromosomes, 44 are allosomes and 2 are autosomes. In female XY and in male XX are sex chromosomes. Human chromosomes are normally taken from Red blood corpuscles (RBCs) from the peripheral blood. The banding patterns of chromosomes indicate that all human races such as Asian, African and European possess different chromosome number.

Assertion & Reason

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as :
(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true but R is not the correct explanation of A
(c) If A is true but R is false (d) If A is false but R is true.

19. **Assertion :** Louis Pasteur showed that in flask open to air, new living organisms appeared in the heat-killed yeast culture.
Reason : Life arises from pre-existing life.

20. **Assertion :** Hardy-Weinberg principle explains the variations occurring in population and species over a number of generations.
Reason : Hardy-Weinberg principle is applicable only when genetic drift does not occur.

21. **Assertion :** Analogy indicates common ancestry.
Reason : Analogy is based on convergent evolution.

22. **Assertion :** Homologous organs show convergent evolution.
Reason : Homologous organs have same origin and different functions.

23. **Assertion :** Industrial melanism supports evolution by natural selection.
Reason : After industrialisation, white moths were selectively picked up by predator birds whereas black moths escaped unnoticed resulting in more population.

24. **Assertion :** Adaptive ability is inherited.
Reason : Fitness is the end result of the ability to adapt and get selected by the nature.

25. **Assertion :** *Homo habilis* was called the hominid.
Reason : The brain capacities of *Homo habilis* were 650 - 800cc.

26. **Assertion :** Neanderthal man is the intermediate between *Ramapithecus* and *Homo erectus*.
Reason : Neanderthal man, with brain size of 1400cc, used hides to protect their body.

Riddle **ANSWER**

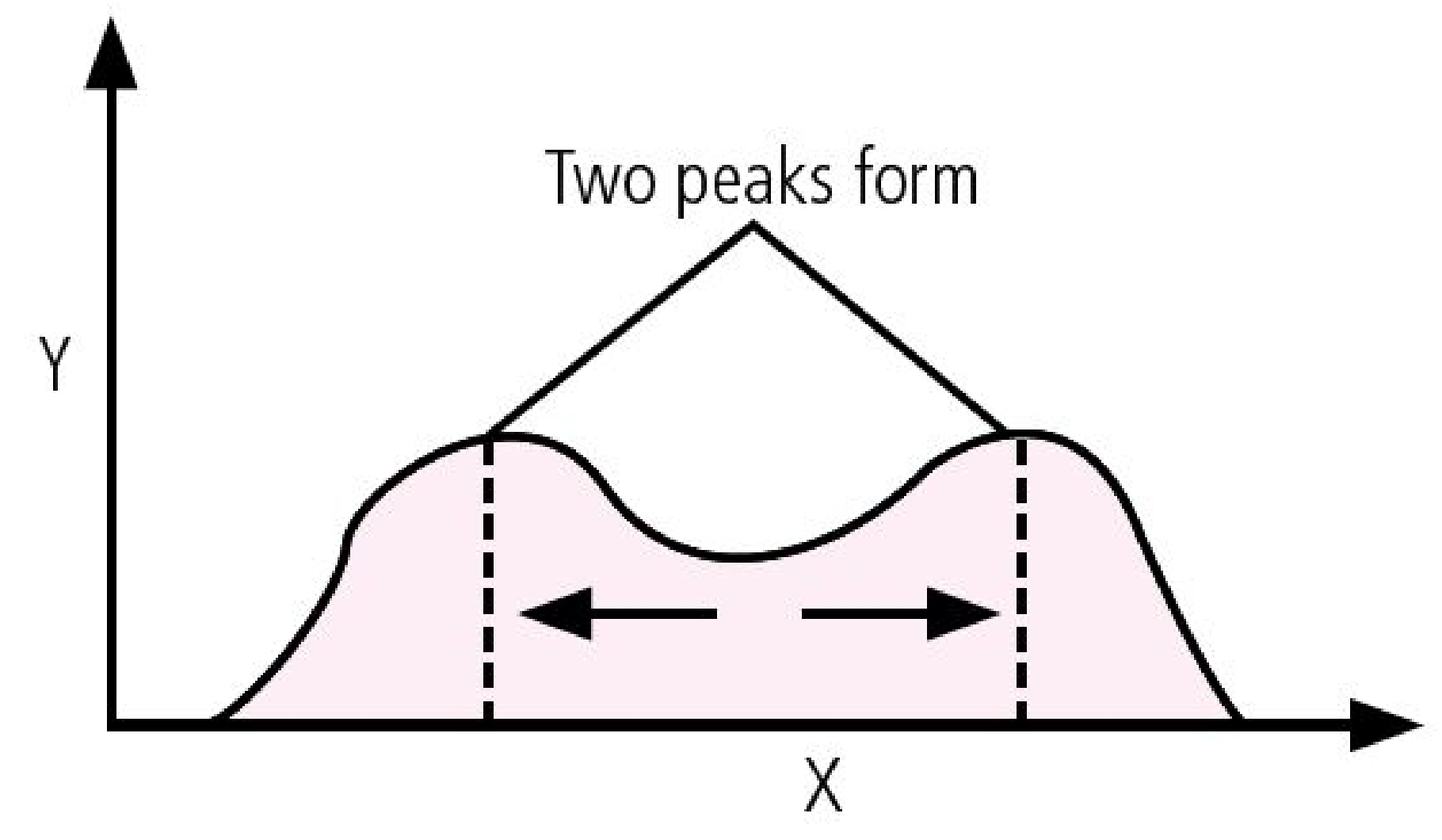
Virus Pg. 31

27. **Assertion :** *Dryopithecus africanus* is a common ancestor of man and great apes.
Reason : *Dryopithecus* gave rise to *Ramapithecus*.

28. **Assertion :** Moths living in the industrial areas became dark to match body colour to the tree trunks.
Reason : Moths were able to camouflage themselves.

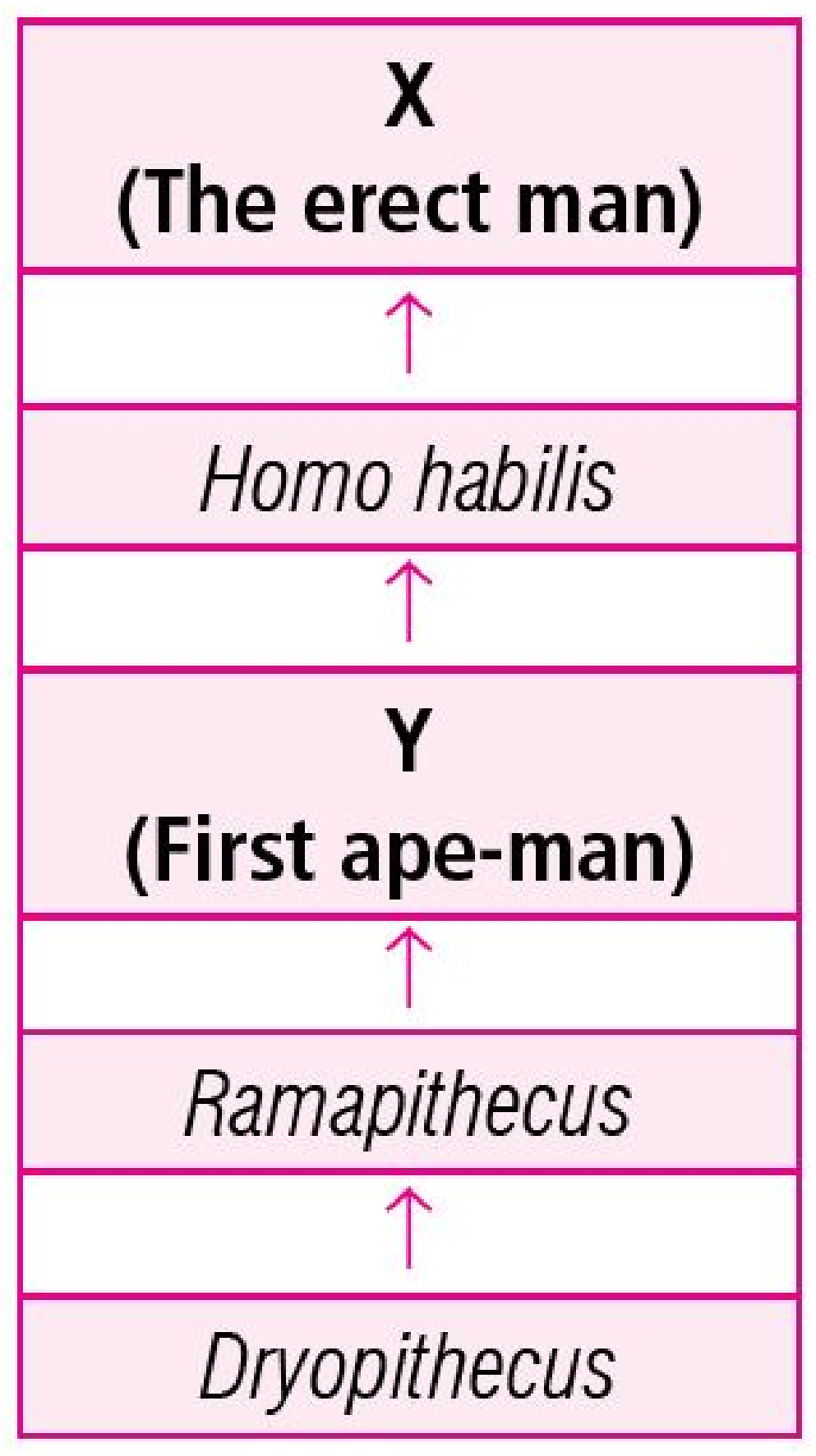
Figure Based Questions

29. Refer to the graph shown below and answer the following questions.



(a) What type of selection does the graph represent?
(b) What do the X and Y represent?
(c) Which type of selection will be generated if one of the peaks start to grow?

30. Refer to the given figure and answer the following questions.



(a) Identify 'X' and 'Y '.
(b) What is the brain capacity of 'X' ?
(c) Write characteristic feature of Y.

SOLUTIONS

CHAPTER-4 : PRINCIPLES OF INHERITANCE AND VARIATION

1. (c) **2.** (c) **3.** (b) **4.** (d) **5.** (d)
6. (b) **7.** (a) **8.** (d) **9.** (c) **10.** (d)
11. (b) **12.** (b) **13.** (a) **14.** (c) **15.** (b)

16. A-(iii); B-(iv); C-(i); D-(ii)

17. A-(vi,vii); B-(i); C-(ii, iv); D-(iii); E (v, viii)

18. **(A)** (i) unaffected (ii) mutation
(iii) haemoglobin (iv) anaemia
(v) HBA1 (vi) HBA2
(vii) 16 (viii) single
(ix) HBB (x) sickle-cell anaemia

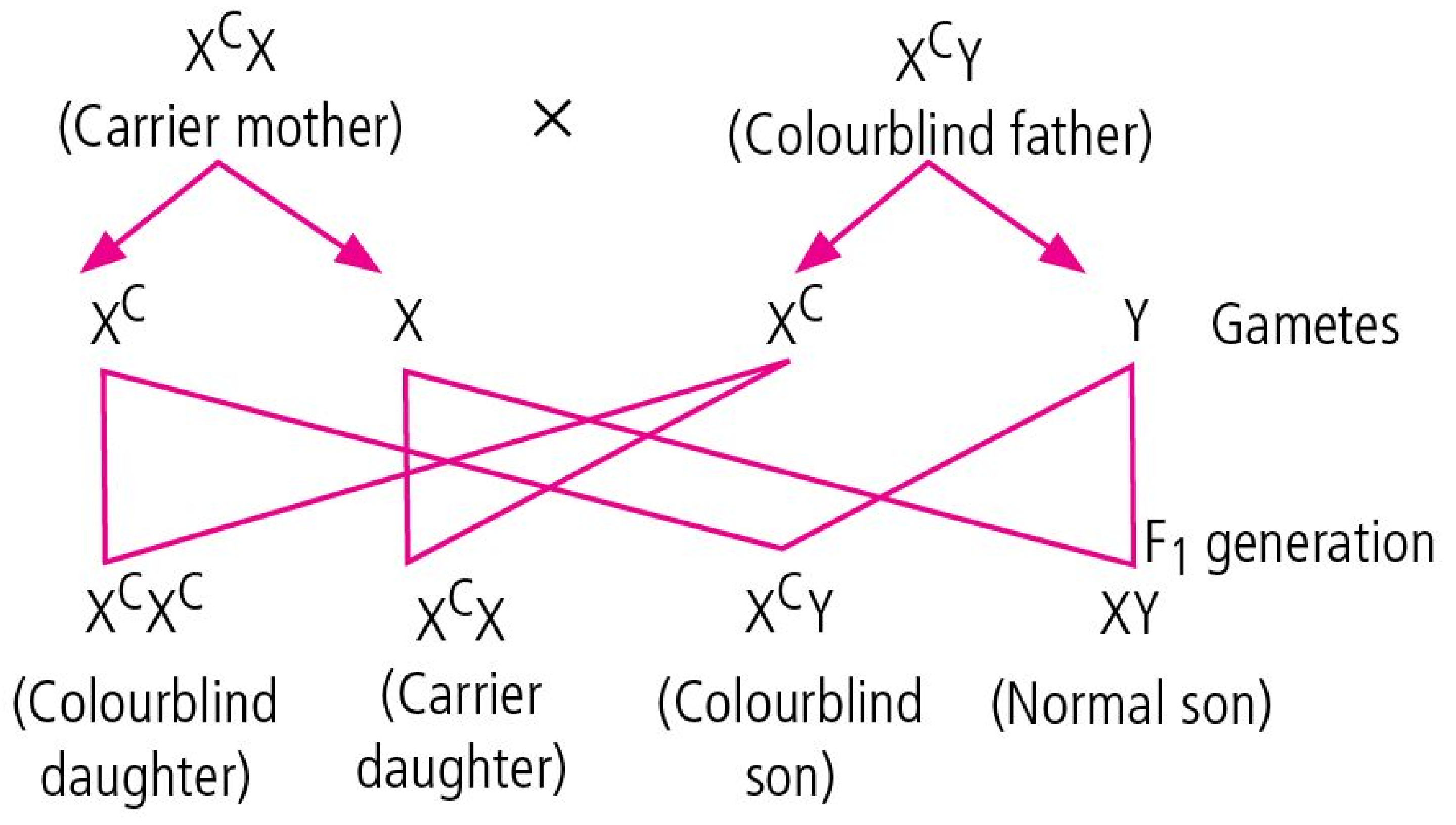
(B) Colour blindness is a ~~autosome~~ sex-linked recessive disorder due to defect in either red or green cone of eye resulting in failure to discriminate between red and green colour. This defect is due to ~~deletion~~ mutation in certain genes present on the X chromosome. It occurs in about 8 per cent of ~~females~~ males and only about 0.4 per cent of ~~males~~ females. This is because the genes that lead to red-green colour blindness are on the X chromosome. The son of a woman who carries the gene has a 50 per cent chance of being colour blind. The mother is not herself colour blind because the gene is ~~dominant~~ recessive. That means that its effect is suppressed by her matching ~~recessive~~ dominant normal gene. A daughter will not normally be colour blind, unless her mother is a carrier and her father is colour blind.

19. (c) **20.** (c) **21.** (a) **22.** (b) **23.** (c)
24. (a) **25.** (c) **26.** (a) **27.** (b) **28.** (d)

29. **(a)** The given pedigree shows the inheritance of X-linked traits. The genes for X linked traits are located on non-homologous segment of X chromosome. The genes for these characters show criss-cross inheritance as the gene for these characters are inherited from mother to his son and from son to his daughter in F_2 generation.

(b) Haemophilia and colourblindness are two diseases that are X linked and are inherited through the similar pattern.

(c) If both the parents are suffering from the X linked disease, then the probability of having disease in F_1 generation would be 50% as explained by the cross.

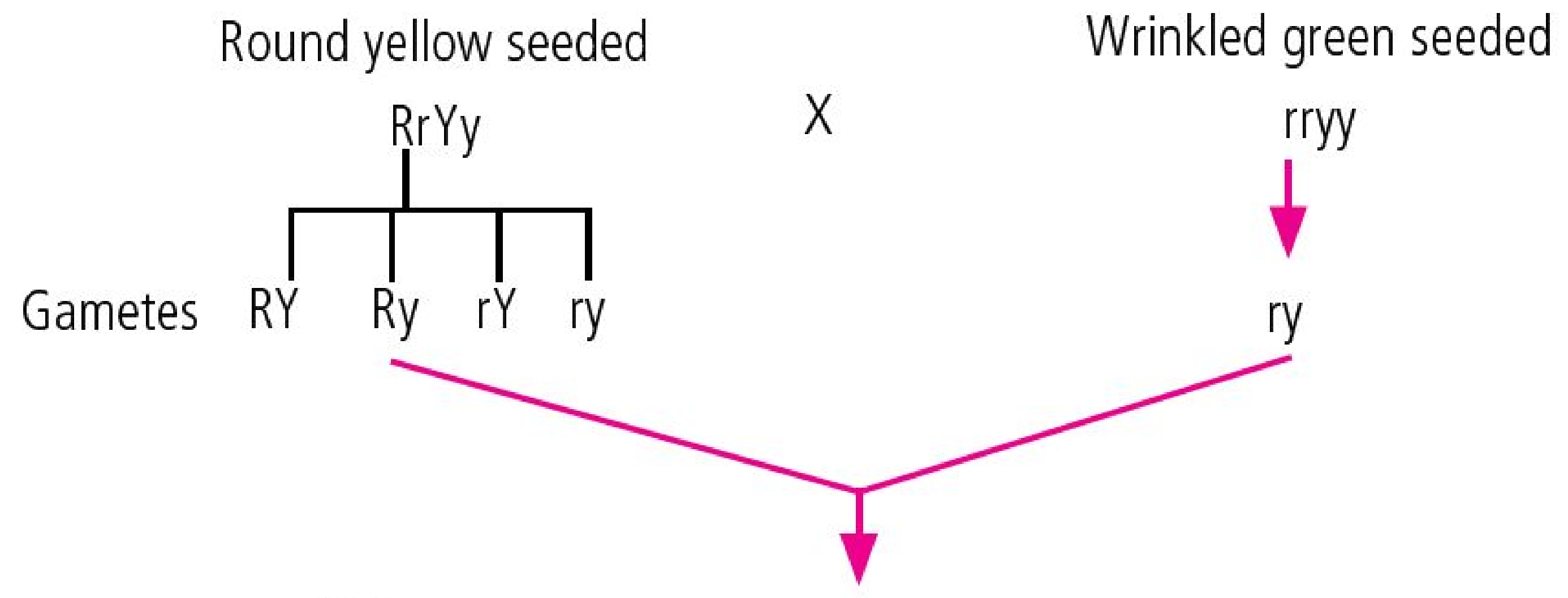


The F_1 progeny would have 25% healthy, 25% carrier and 50% diseased offspring.

30. The given cross represents the dihybrid cross. The total number of seeds produced in F_2 generation are 1600.

(a) The analysis of cross reveals that the number of seeds heterogenous for yellow colour and homogenous for round seed shape are 2 out of 16.
Therefore, the total number of seeds heterogenous for yellow colour and homogenous for round seed shape are:
$= 2/16 \times 1600 = 200$

(b) The cross between F_1 hybrids with wrinkled green seeded plants (rryy) can be explained with the help of following cross :



		RY	Ry	rY	ry
F_2 generation	ry	RrYy Round yellow	Rryy Round green	rrYy Wrinkled yellow	rryy Wrinkled green

The phenotypic ratio obtained in F_2 generation is 1:1:1:1 and the genotypic ratio obtained in F_2 generation is 1:1:1:1.

(c) According to the given cross, the seeds homogenous for round seed shape and green colour are 1/16. Therefore, the total number of round green seeds obtained is 100.
Homogenous round green seeds = 1/16 × 1600 = 100

CHAPTER-5 : MOLECULAR BASIS OF INHERITANCE

1.	(a)	**2.**	(c)	**3.**	(c)	**4.**	(a)	**5.**	(d)
6.	(c)	**7.**	(c)	**8.**	(b)	**9.**	(a)	**10.**	(a)
11.	(b)	**12.**	(b)	**13.**	(b)	**14.**	(d)	**15.**	(d)

16. A-(ii), B-(iv), C-(i), D-(v)

17. A-(ii, v), B-(iii, viii), C-(iv, vi), D-(i, vii)

18. **(A)** (i) repetitive (ii) genomic
(iii) centrifugation (iv) satellite
(v) micro-satellites (vi) mini-satellites
(vii) proteins (viii) polymorphism
(ix) forensic (x) inheritable

(B) Translation refers to the process of polymerisation of ~~nucleotides~~ amino acids to form ~~amino acids~~ polypeptide. The order and sequence of amino acids are defined by the sequence of bases in the ~~*t*RNA~~ *m*RNA. Eukaryotic translation occurs on ~~70S~~ 80S ribosomes. It is a discontinuous process as transcription occurs in ~~cytoplasm~~ nucleus while translation takes place in ~~nucleus~~ cytoplasm.

19.	(a)	**20.**	(a)	**21.**	(a)	**22.**	(b)	**23.**	(b)
24.	(a)	**25.**	(a)	**26.**	(d)	**27.**	(d)	**28.**	(b)

29. **(a)** The given figure represents the band pattern based on DNA fingerprinting technique. DNA fingerprinting is a technique that simultaneously detects lots of minisatellites in the genome to produce a pattern unique to an individual.

(b) Paternity, can be legally established in several ways. Usually blood-group studies, which commonly employ the ABO system, cannot establish paternity but can conclusively exclude an alleged father from being a candidate. A typical population frequency for conventional blood typing might be one in 200, for DNA one in 5,000,000. This means that only one in 5,000,000 people would have the same DNA profile. Adequate samples for DNA typing can be collected from blood, blood stain and oral swab easily. DNA typing compares strands of genetic material between the child and alleged father comparing strands from various locations of the genetic material allows accuracy ratings of 99.9%. DNA typing allows an alleged father to be excluded with 100% certainty.

(c) According to the given figure, Dad 2 would be the actual father of the baby as it shows maximum similarity with baby in DNA bands.

30. **(a)** The given figure represents two molecules A-Guanine, B-Thymine. Guanine is a kind of purine (a two ringed, heterocyclic nitrogenous compound) and thymine is a kind of pyrimidine (single ringed nitrogenous compound).

(b) Purines (adenine and guanine) and pyrimidine (thymine, cytosine and uracil) are involved in making nucleic acids-DNA and RNA. Purines and pyrimidines are an important ingredient of the DNA along with the phosphate and the pentose sugar. They form the backbone of nucleic acid as nucleotides. Thymine is found in DNA only.

(c) In DNA, guanine pairs with cytosine with three hydrogen bonds and thymine pairs with adenine with two hydrogen bonds.

CHAPTER-6 : EVOLUTION

1.	(a)	**2.**	(b)	**3.**	(d)	**4.**	(b)	**5.**	(b)
6.	(d)	**7.**	(d)	**8.**	(b)	**9.**	(b)	**10.**	(d)
11.	(b)	**12.**	(c)	**13.**	(d)	**14.**	(d)	**15.**	(c)

16. A-(iv); B-(iii); C-(ii); D-(i)

17. (A)-(iii), (B)-(iv), (C)-(v), (D)-(ii)

18. **(A)** (i) natural selection (ii) phenotypic
(iii) stabilising (iv) variation
(v) bell-shaped (vi) mean
(vii) Disruptive (viii) populations
(ix) evolution (x) directional

(B) Each ~~gorilla~~ human somatic cell contains 46 chromosomes. Out of these chromosomes, 44 are ~~allosomes~~ autosomes and 2 are ~~autosomes~~ allosomes. In female ~~XY~~ XX and in male ~~XX~~ XY are the sex chromosomes. Human chromosomes are normally taken from ~~Red blood corpuscles (RBCs)~~ White blood corpuscles (WBCs) from the peripheral blood. The banding patterns of chromosomes indicate that all human races such as Asian, African and European possess ~~different~~ same chromosome number.

19.	(b)	**20.**	(d)	**21.**	(d)	**22.**	(d)	**23.**	(a)
24.	(b)	**25.**	(b)	**26.**	(d)	**27.**	(b)	**28.**	(d)

29. **(a)** The graph represents disruptive selection.

(b) The X represents phenotypes in a population while Y represents number of individuals in the population.

(c) If one of peak starts grow then directional selection will be obtained where more individuals acquire value other than the mean character value.

30. **(a)** In this representation of evolution of man, X and Y represent Homo erectus and *Australopithecus*, respectively.

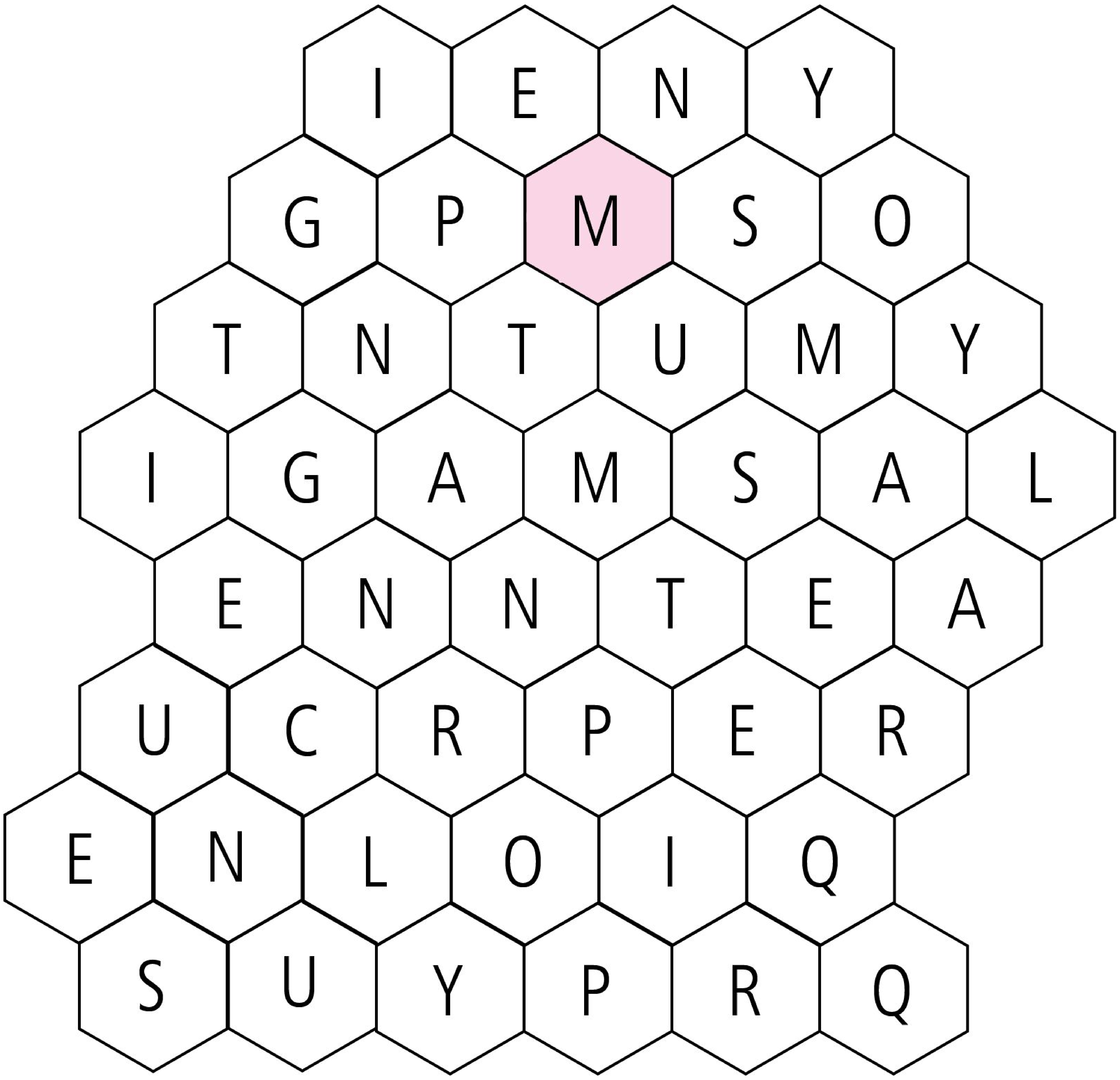
(b) As X is *Homo erectus*, therefore its brain capacity is 900cc.

(c) *Australopithecus* (Y) was with bipedal locomotion, omnivorous diet and had erect posture. It had human-like teeth. Its brain capacity was about 500cc. *Australopithecus* lived in East African grasslands about 2 mya. ☺☺

BIO BUZZ

The given honeycomb contains 7 letter words for the given clues. Find the words for the given clues and shade the center letter of each word. [**Hint :** The shaded letter M and the six letters surrounding it spell a word that matches one of the clues below].

1. Organisms that have undergone a mutation ________
2. Brain of cell ________
3. Made up of amino acids ________
4. Triggers an immune response ________
5. Enzyme that breaks starch into sugar ________
6. Responsible for colour of tissues ________


I E N Y
G P M S O
T N T U M Y
I G A M S A L
E N N T E A
U C R P E R
E N L O I Q
S U Y P R Q

*Please send entries of solutions both with words and scanned copy of the grid within 10th of every month.

CBSE

Warm-up!

CLASS-XII

Chapterwise Practice Paper for CBSE Exams as per the latest pattern and syllabus by CBSE for the academic session 2025-26.

UNIT-VI : REPRODUCTION

General Instructions :

Read the following instructions carefully and follow them :

(i) This question paper contains ***33*** *questions.* ***All*** *questions are* ***compulsory****.*

(ii) Question paper is divided into ***five*** *sections – Sections* ***A****,* ***B****,* ***C****,* ***D*** *and* ***E****.*

(iii) ***Section A*** *– questions number* ***1*** *to* ***16*** *are multiple choice type questions. Each question carries* ***1*** *mark.*

(iv) ***Section B*** *– questions number* ***17*** *to* ***21*** *are very short answer type questions. Each question carries* ***2*** *marks.*

(v) ***Section C*** *– questions number* ***22*** *to* ***28*** *are short answer type questions. Each question carries* ***3*** *marks.*

(vi) ***Section D*** *– questions number* ***29*** *and* ***30*** *are case-based questions. Each question carries* ***4*** *marks. Each question has subparts with internal choice in one of the subparts.*

(vii) ***Section E*** *– questions number* ***31*** *to* ***33*** *are long answer type questions. Each question carries* ***5*** *marks.*

(viii) There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for only ***one*** *of the alternatives in such questions.*

(ix) Wherever necessary, neat and properly labelled diagrams should be drawn.

Time Allowed : 3 hours

Maximum Marks : 70

SECTION-A

Question Nos. 1 to 16 are Multiple Choice Questions, carrying 1 mark each.

1. Angiosperms are economical and more specialised as compared to gymnosperms because

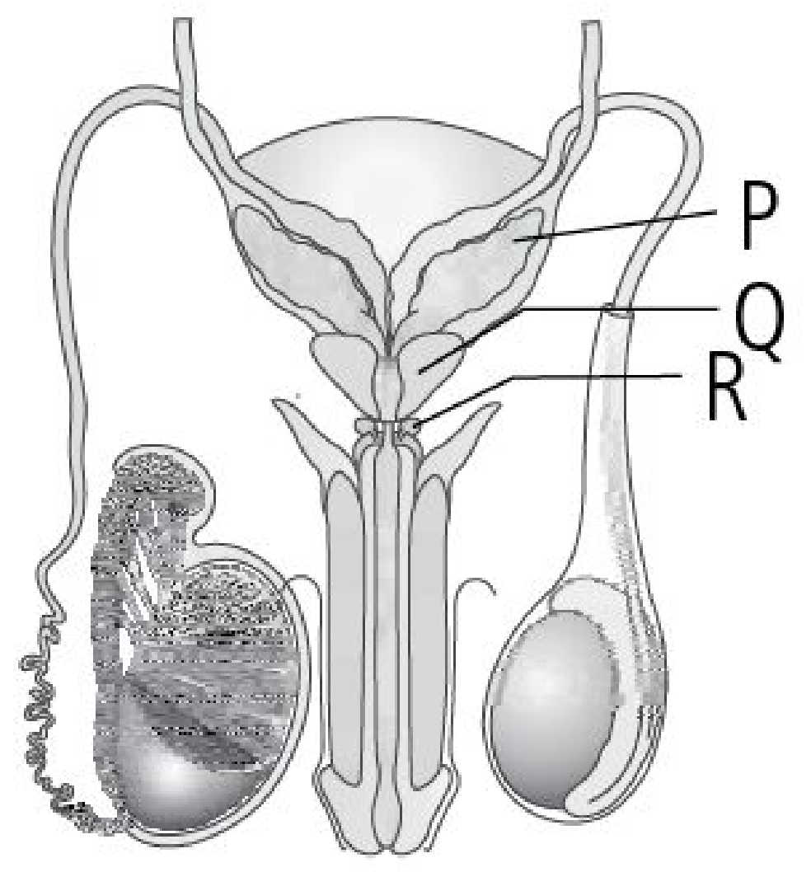
(a) nutritive female gametophyte is formed long before fertilisation

(b) nutritive tissue is formed only when the formation of zygote has taken place

(c) nutritive tissue does not form at all

(d) none of these.

2. Identify the parts of male reproductive system from given characteristics.



(i) Produces milky secretion with pH 6.5 which nourishes spermatozoa to swim.

(ii) Present on either side of membranous urethra and secrete mucus that lubricates end of penis.

(iii) Their ducts join vasa deferentia to form ejaculatory ducts.

	(i)	(ii)	(iii)
(a)	Q	P	R
(b)	P	R	Q
(c)	Q	R	P
(d)	P	Q	R

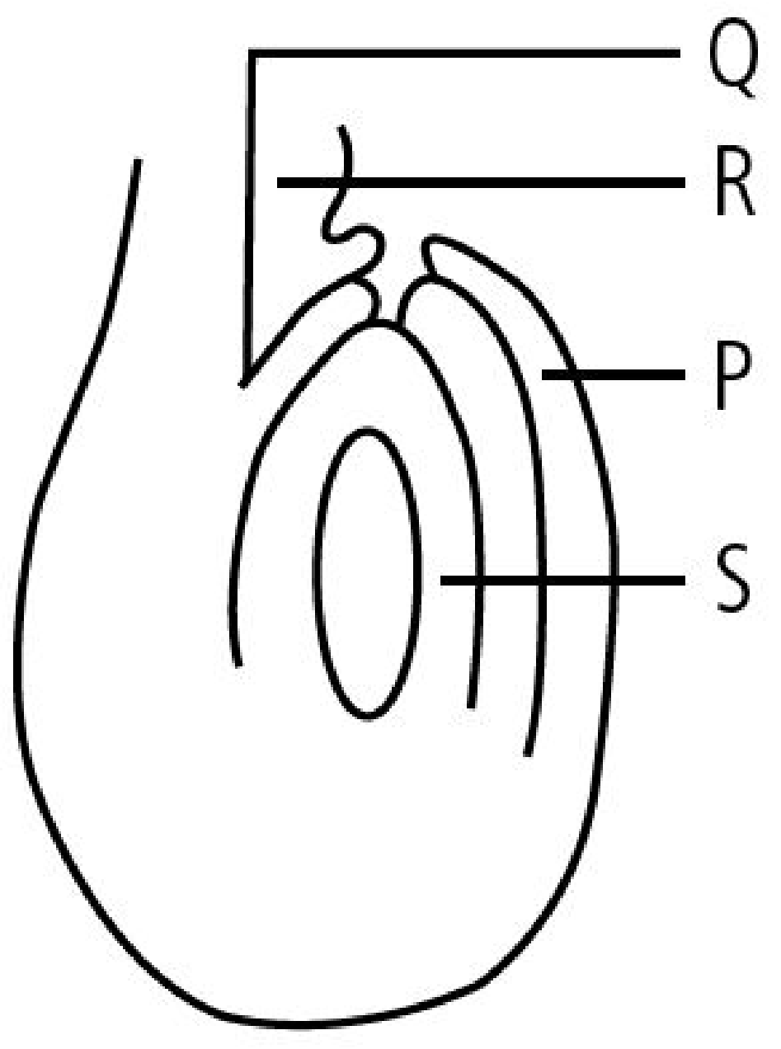
3. Given below are the events that are observed in an artificial hybridisation programme. Arrange them in the correct sequential order and select the correct option.

1. Re-bagging
2. Selection of parents
3. Bagging
4. Dusting the pollens on stigma
5. Emasculation
6. Collection of pollens from male parent

(a) $2 \rightarrow 3 \rightarrow 5 \rightarrow 6 \rightarrow 4 \rightarrow 1$
(b) $2 \rightarrow 5 \rightarrow 3 \rightarrow 6 \rightarrow 4 \rightarrow 1$
(c) $5 \rightarrow 2 \rightarrow 3 \rightarrow 6 \rightarrow 1 \rightarrow 4$
(d) $2 \rightarrow 3 \rightarrow 6 \rightarrow 4 \rightarrow 5 \rightarrow 1$

4. Contraceptive method which involves abstaining from sex during ovulatory phase is
(a) withdrawal method
(b) rhythm method
(c) vasectomy
(d) lactational amenorrhea method.

5. Refer to the given figure and identify the part



(i) that develops into seed coat
(ii) that attaches the ovule to the placenta.
(a) (i) – P, (ii) – Q
(b) (i) – P, (ii) – R
(c) (i) – R, (ii) – S
(d) (i) – R, (ii) – Q

6. Select the incorrect statements.
I. In hypogeal germination, epicotyl elongates so that cotyledons remain in the soil.
II. Perisperm is the covering of fruit that develops from ovary wall.
III. Persistent nucellus is found in black pepper and cardamom.
IV Embryos formed through apomixis are generally full of infections.
(a) I and III
(b) I and IV
(c) II and IV
(d) I and III

7. Match the column I with column II and select the correct answer by choosing an appropriate option.

Column I	**Column II**
(A) Acrosome	(i) Erectile tissue
(B) Myometrium	(ii) Uterus
(C) Polar body	(iii) Oogenesis
(D) Clitoris	(iv) Spermatozoan

(a) A - (ii), B - (i), C - (iv), D - (iii)
(b) A - (iv), B - (ii), C - (iii), D - (i)
(c) A - (iv), B - (iii), C - (ii), D - (i)
(d) A - (iv), B - (iii), C - (i), D - (ii)

8. Diaphragms are contraceptive devices used by the females. Choose the correct option from the statements given below.
(a) They are introduced into the uterus.
(b) They are placed to cover the cervical region.
(c) They act as physical barriers for sperm entry.
(d) Both (b) and (c)

9. Emasculation is not required if the flowers are
(a) pistillate
(b) staminate
(c) bisexual
(d) both (a) and (b).

10. Which part of mammalian ovary secretes progesterone?
(a) Graafian follicle
(b) Corpus luteum
(c) Corpus albicans
(d) Tertiary follicle

11. Increased IMR and decreased MMR in a population will
(a) cause rapid increase in growth rate
(b) result in decline in growth rate
(c) not cause significant change in growth rate
(d) result in a population explosion.

12. The root cell of angiospermic plant has 42 chromosomes. What would be the number of chromosomes in the synergid cell?
(a) 21
(b) 7
(c) 28
(d) 14

Q. No. 13 to 16 consists of two statements – Assertion (A) and Reason (R). Answer these questions by selecting the appropriate option given below:

(a) Both (A) and (R) are true and (R) is the correct explanation of the (A).
(b) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true.

13. **Assertion (A) :** Mons pubis is the anterior most portion of external genitalia.
Reason (R) : Mons pubis contains erectile tissue.

14. **Assertion (A) :** GIFT solves the problem of infertility by the transfer of an ovum from a donor female into the Fallopian tube of another female.
Reason (R) : Recipient female cannot produce ovum but provides suitable environment for fertilisation and embryo development.

15. **Assertion (A) :** Megaspore mother cell undergoes meiosis to produce 4 megaspores.
Reason (R) : Megaspore mother cell and the megaspores are haploid and diploid respectively.

16. **Assertion (A) :** Spermiogenesis is the transformation of spermatids into spermatozoa.
Reason (R) : One spermatid develops into one spermatozoon during spermiogenesis.

SECTION-B

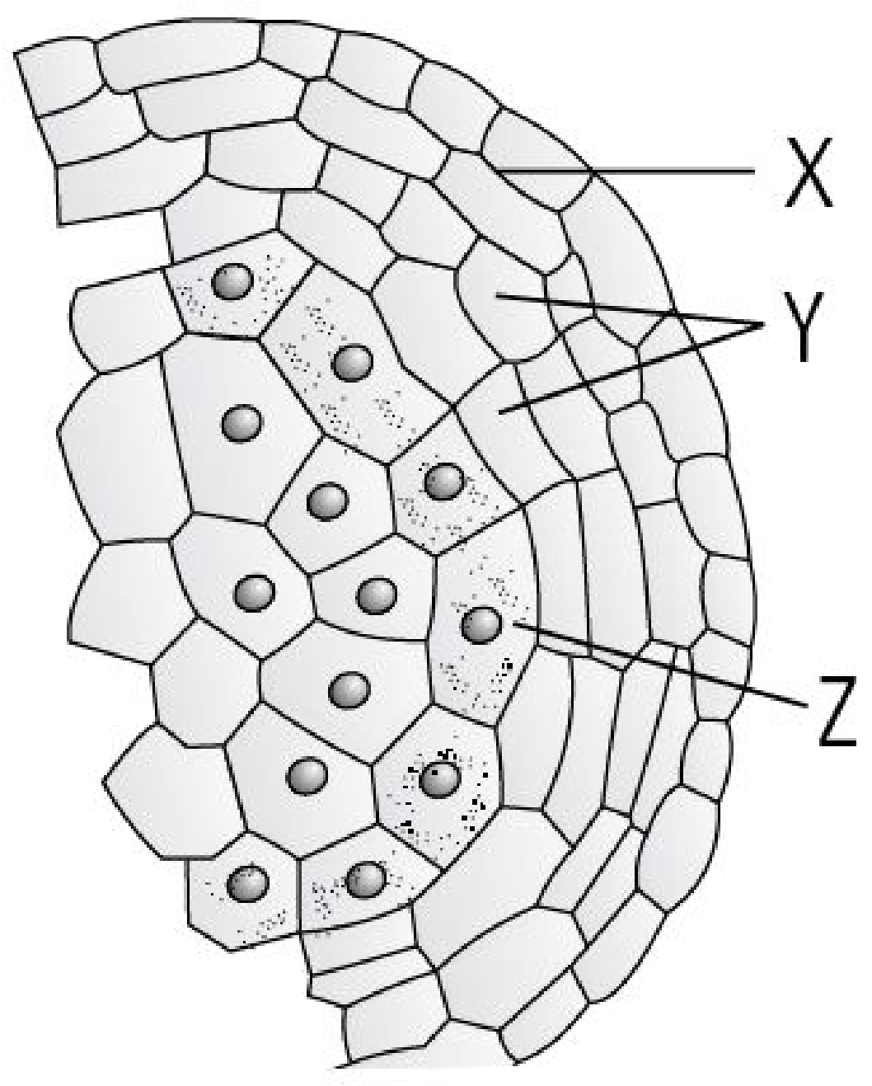
17. *Student to attempt either option (a) or (b).*

(a) What do you think is the significance of reproductive health in a society?

OR

(b) Suggest the aspects of reproductive health which need to be given special attention in the present scenario.

18. Refer to the given figure.



(a) Identify X , Y and Z.

(b) Mention the characteristics and function of the Z.

19. *Student to attempt either option (a) or (b).*

(a) Describe the three layers of uterus wall.

OR

(b) Write three functions of male and female reproductive system.

20. **(a)** What is amniocentesis? How is it misused?

(b) What are the probable factors that contributed to population explosion in India?

21. Explain the composition of wall layers of pollen grains.

SECTION-C

22. **(a)** Write the function of oxytocin.

(b) Why is parturition called a neuro-endocrine mechanism?

23. **(a)** What are barrier methods? Give two examples.

(b) What is the difference between contraception and abortion?

24. Write characteristics of the two cells enclosed in a mature male gametophyte of an angiosperm.

25. Draw a diagram of a mature human sperm. Label any three parts and write their functions.

26. **(a)** List any two reasons other than physical and congenital disorders for causing infertility in couples.

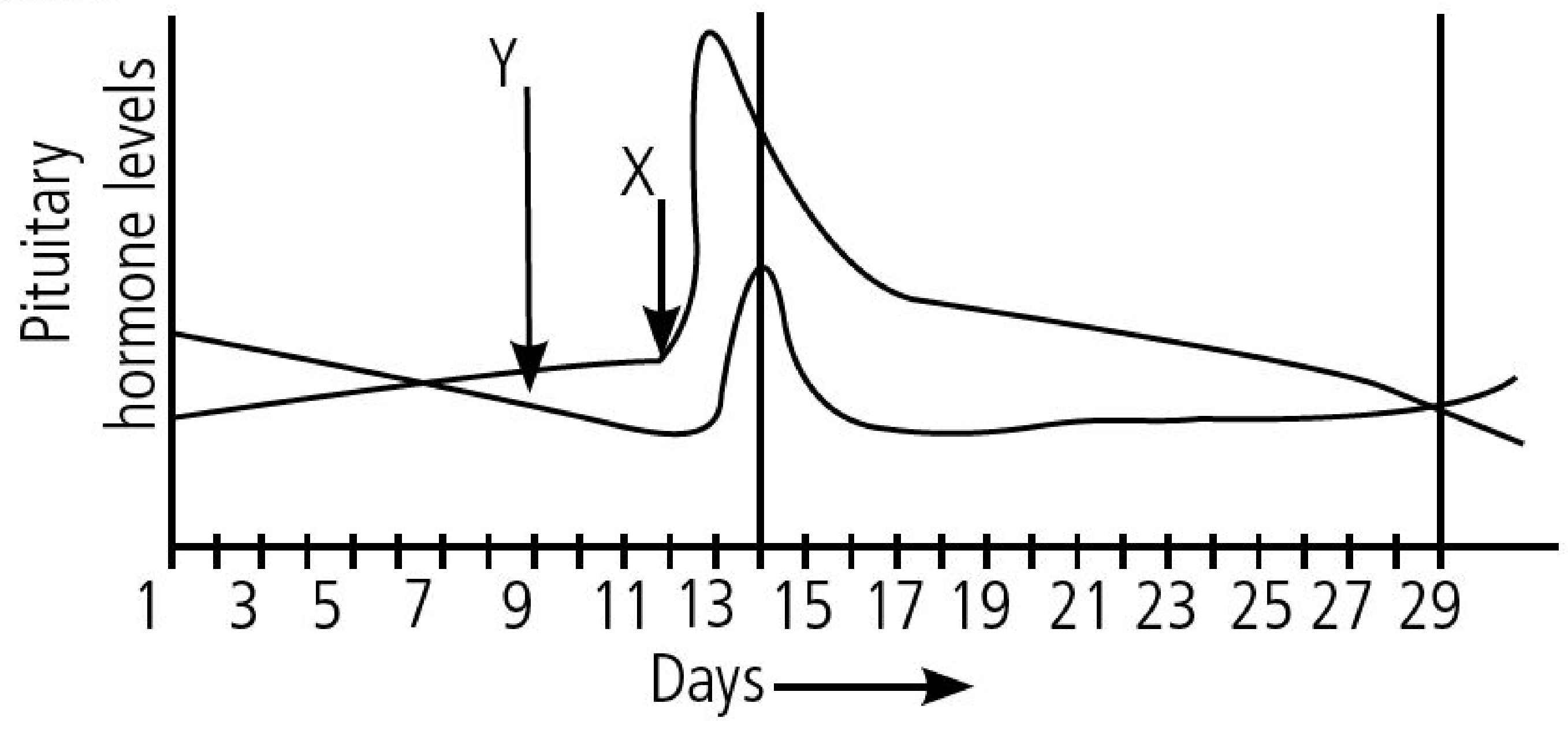
(b) Explain how IVF as a technique helped childless couples in having children.

(c) Compare GIFT with ZIFT.

27. **(a)** State the function of filiform apparatus found in mature embryo sac of an angiosperm.

(b) Why an anther with malfunctioning tapetum often fails to produce viable male gametophytes?

28. Study the graph given below and answer the questions that follow.



(a) Name the hormones 'X' and 'Y'.

(b) Identify the ovarian phases during given days of menstrual cycle.

(i) 6th-13th day of the cycle.

(ii) 14th day of the cycle.

(iii) 15th-28th day of the cycle.

(c) Explain the ovarian phases (i), (ii) and (iii) under the influence of hormones 'X' and 'Y'.

SECTION-D

Q. Nos. 29 and 30 are case based questions. Each question has 3 sub-questions with internal choice in one sub-question.

29. Over population causes number of family problems. Strategies like birth control methods help to control population explosion. There are various types of birth

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control methods. X type of birth control do not involve medications or devices to prevent pregnancy but rather rely on behavioural practices and/or making observations about menstrual cycle.

(a) What could be X?

(b) On what principle does X work?

Attempt either sub-part (c) or (d).

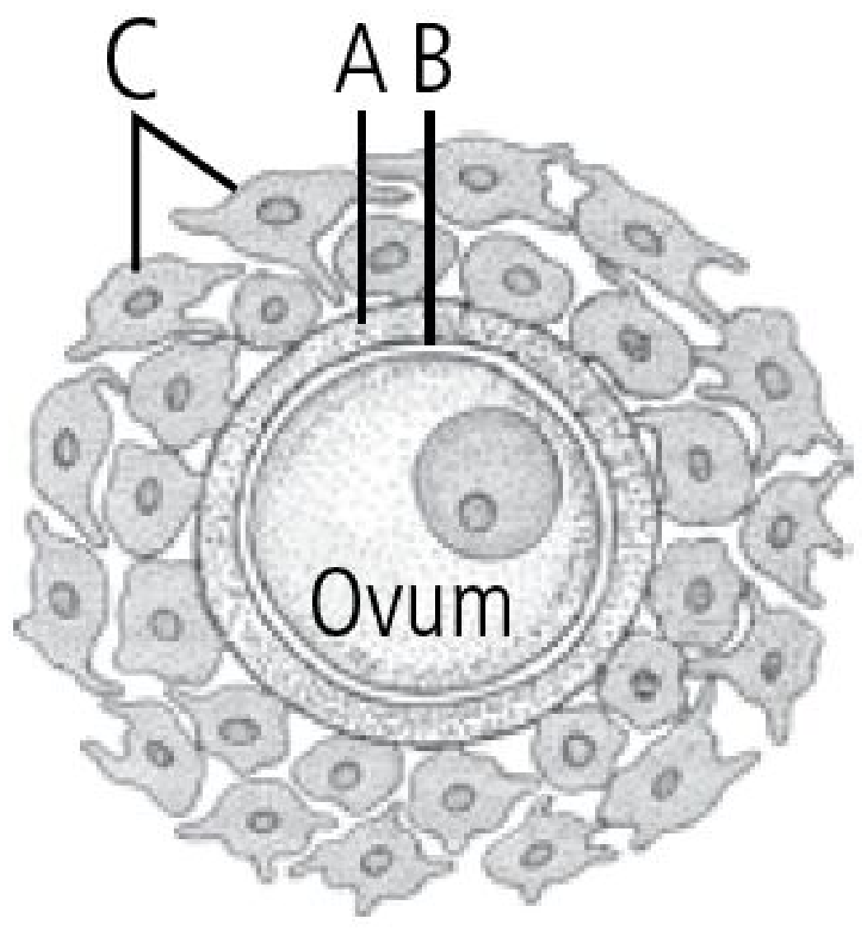
(c) Give examples of X.

OR

(d) Enlist the advantages and disadvantages of method X.

30. The process of fusion of a sperm with an ovum is called fertilisation. During fertilisation, a sperm comes in contact with the zona pellucida layer of the ovum and induces changes in the membrane that block the entry of additional sperms.

Observe the given figure carefully and answer the following questions.



(a) What is the role of A in the given figure?

(b) Explain B.

Attempt either sub-part (c) or (d).

(c) Identify C.

OR

(d) What changes will take place when sperm reaches A?

SECTION-E

31. *Student to attempt either option (a) or (b).*

(a) **(i)** State any two reasons responsible for the cause of infertility.

(ii) Suggest the technique that can help the couple to have a child where the problem is with the male partner.

OR

(b) **(i)** A couple where both husband and wife are producing functional gametes, but the wife is still unable to conceive, is seeking medical aid. Describe any one method that you can suggest to this couple to become happy parents.

(ii) Why are copper containing intrauterine devices considered an ideal contraceptive for human females?

32. *Student to attempt either option (a) or (b).*

(a) **(i)** Draw a labelled longitudinal section of an albuminous seed.

(ii) How are seeds important to flowering plants?

OR

(b) **(i)** Draw a labelled diagram of the sectional view of a mature pollen grain in angiosperm.

(ii) Explain the functions of any four labelled parts.

33. *Student to attempt either option (a) or (b).*

(a) **(i)** Meiotic division during oogenesis is different from that in spermatogenesis. Explain how?

(ii) Why there is a difference in meiotic divisions of oogenesis and spermatogenesis?

OR

(b) **(i)** At which phase of menstrual cycle does LH attain a peak level? State the main features of this phase.

(ii) How the production of progesterone gets increased in secretory phase?

SOLUTIONS

1. **(b) :** Double fertilisation ensures that the nutritive tissue is formed only when the formation of zygote has taken place by fertilisation of the oosphere or egg. Angiosperms are, therefore, economical and more specialised as compared to gymnosperms where a large nutritive female gametophyte is formed long before fertilisation. If fertilisation fails, the energy spent on forming it shall go waste.

2. **(c) :** P-Seminal vesicle; Q-Prostate; R-Bulbourethral gland.

3. **(b)**

4. **(b) :** Periodic abstinence or rhythm method is the natural method of birth control, in which couples avoid intercourse from day 10-17 of menstrual cycle because ovulation occurs during this period (generally 14th day).

5. **(b) :** In the given figure P, Q, R and S are integuments, hilum, funicle and nucellus respectively. Integuments develop into seed coat, ovule is attached to placenta by means of stalk called funicle.

6. **(c) :** Perisperm is the unused nucellus in the seed. Embryos formed through apomixis are generally infection free.

7. **(b)** **8. (d)**

9. **(d) :** Emasculation is not required if the flowers are unisexual, *i.e.*, staminate and pistillate.

10. **(b)**

11. **(b) :** If there is an increase in infant mortality rate (IMR) and decrease in maternal mortality rate (MMR), mothers are available to give birth to infants but the infants' survival rate is low, which will ultimately hinder the growth rate of that particular population.

12. **(a) :** In angiospermic plant, root cells are diploid structure whereas synergid is haploid structure. So, if root cell of angiospermic plant has 42 chromosomes then number of chromosomes in the synergid cell will be 21.

13. (c) : Clitoris contains erectile tissue.

14. (a)

15. (c) : Megaspore mother cell is diploid whereas megaspores are haploid structures.

16. (b)

17. (a) Reproductive health is the total well being in all aspects of reproduction. It includes physical, emotional, behavioural and social well being. Lack of awareness among youth about unprotected sex, may lead to sexually transmitted diseases such as AIDS, syphilis, etc. and unwanted pregnancies. Hence, it is necessary to create awareness among people, especially the youth regarding various reproduction related aspects as the young individuals are the future of the country and they are most susceptible of acquiring sexually transmitted diseases. Creating awareness about the available birth control methods, sexually transmitted diseases and their preventive measures, and gender equality will help in bringing up a socially conscious healthy family. Spreading awareness regarding uncontrolled population growth and social evils among young individuals will help in building up a reproductively healthy society.

OR

(b) The aspects of reproductive health which need to be given special attention are :

(i) Introduction of sex education in schools to give right information to the young minds about reproductive organs, accessory organs of reproduction, secondary sexual characters, adolescence and related changes, safe and hygienic sexual practices, STDs, etc.

(ii) Providing knowledge about available birth control methods, care of pregnant mothers, post-natal care of the mother and child, importance of breast feeding, etc.

(iii) Creating awareness about consequences of uncontrolled population growth and social evils (sex abuses and sex-related crimes, use of drugs, tobacco and alcohol etc.) among young people.

18. (a) X-Endothecium, Y-Middle layers, Z-Tapetum

(b) Z is tapetum. It is the innermost wall layer of microsporangium. Cells of the tapetum possess dense cytoplasm and generally have more than one nucleus. It nourishes the developing pollen grains.

19. (a) The three layers of tissue in the walls of the uterus are:

(i) the perimetrium is an outer thin covering of peritoneum.

(ii) the myometrium is a middle thick layer of smooth muscle fibres which shows contraction during delivery of the baby.

(iii) the endometrium is the inner glandular layer lining the uterine cavity.

OR

(b) Functions of male reproductive system:

(i) Spermatogenesis : The germinal epithelial cells of seminiferous tubules produce sperms.

(ii) Male sex hormones : Leydig's cells (interstitial cells) produce male sex hormones (*e.g.*, testosterone).

(iii) Transfer of sperms : Copulatory organ (*e.g.*, penis) transfer sperms into the vagina of the female during copulation.

Functions of female reproductive system:

(i) Germinal epithelial cells of the ovary produce ova (oogenesis).

(ii) Fertilisation takes place in the fallopian tube (oviduct).

(iii) After puberty the uterus goes through the menstrual cycle.

20. (a) Amniocentesis is a prenatal diagnostic technique used to determine sex and metabolic disorders of an unborn fetus. This technique is often misused to kill an unborn normal female fetus.

(b) Factors responsible for population explosion are :

(i) Lack of education in developing countries.

(ii) Lack of entertainment and employment in under-developed countries.

(iii) Early marriage and child labour.

(iv) Desire of male child, traditional religious beliefs, etc.

21. The angiosperm pollen grains comprises of outer exine made up of resistant organic material sporopollenin and inner thin layer of intine made up of cellulose and pectin. Since, the outer hard layer of exine is made up of sporopollenin which is one of the most resistant organic substance, it helps the pollen grains to resist high temperatures, strong acids and alkali and it also protects them from enzymatic degradation.

22. (a) Oxytocin acts on the uterine muscle causing their contractions that help in the expulsion of the baby out of the uterus through the birth canal.

ANSWERS JUNE 2025

Across

1. *Paramoecium*
3. Hypogynous
5. Locust
7. Sarcomere

Down

2. Nucleosome
4. Antibody
6. Synergids
8. Wombat

Winner : *Nehal Shrivastava, Punjab*

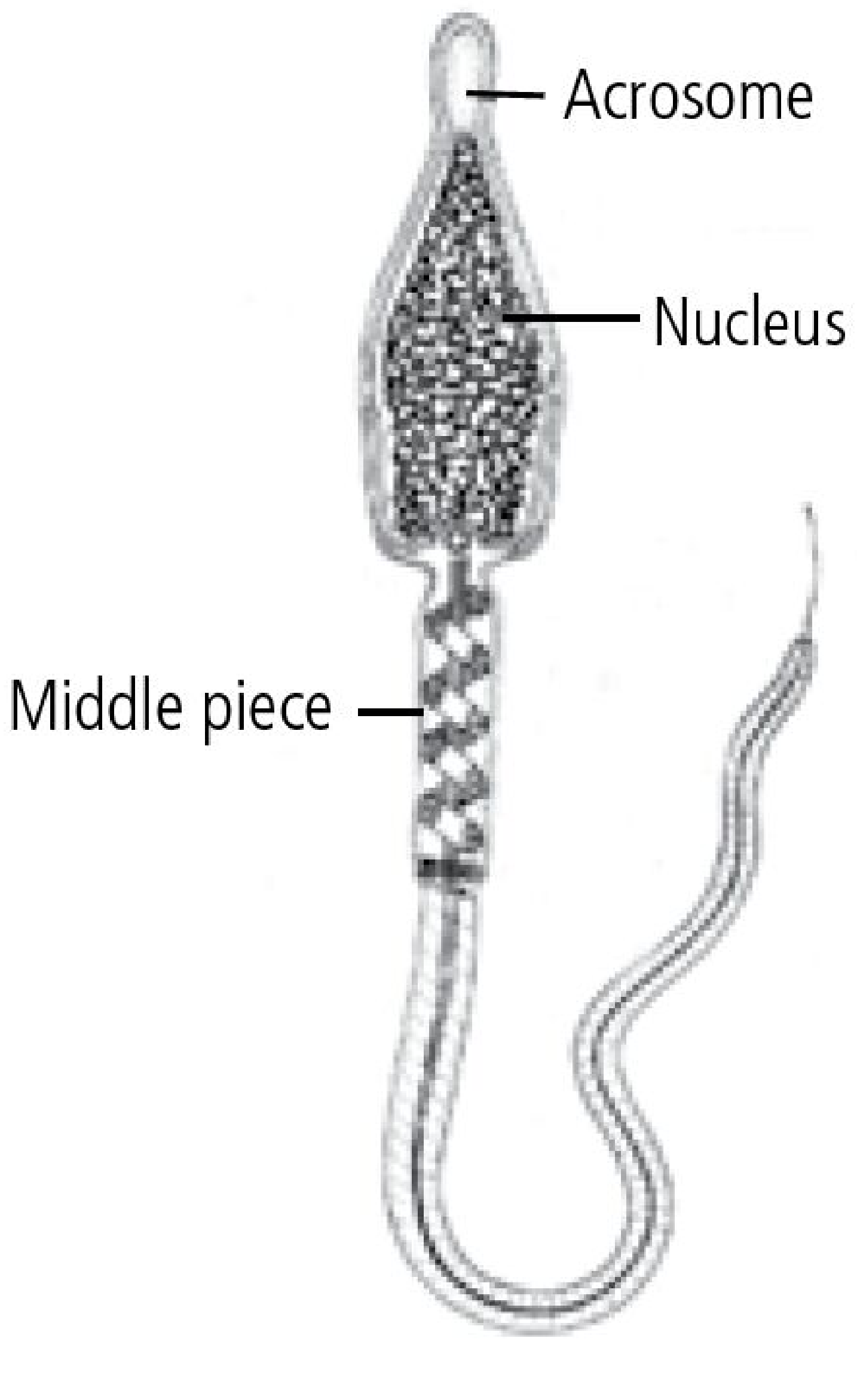
(b) Process of parturition is induced by both neural system and endocrine system therefore, it is called a neuro-endocrine mechanism. The signals for parturition originate from the fully developed fetus and the placenta which induce mild uterine contractions called fetal ejection reflex. This triggers release of oxytocin from the maternal pituitary. Oxytocin acts on the uterine muscle and causes stronger uterine contractions that leads to expulsion of the baby out of the uterus through the birth canal.

23. (a) Barrier methods prevent sperms and ova from physically meeting due to the barriers. They include condom, diaphragm, cervical cap and vault cap. Unlike other methods of birth control, barrier methods are used only during sexual intercourse.

(b) Contraception is the deliberate use of artificial methods or other techniques to prevent pregnancy as a consequence of sexual intercourse. Abortion is termination of pregnancy before the fetus becomes viable, generally performed during first trimester of pregnancy.

24. Haploid pollen grain represents the male gametophyte. It contains two cells, *i.e.*, vegetative cell and generative cell. The vegetative or tube cell is larger in size and with prominent nucleus and vacuolated cytoplasm. The generative cell on the other hand has thin dense cytoplasm surrounding a prominent nucleus.

25. Diagram of a human sperm with labelled parts : Acrosome, nucleus and middle piece is as follows:



Functions:

(i) Acrosome : It is formed from Golgi body and contains enzymes called spermlysins that are used to contact and penetrate the egg at the time of fertilisation.

(ii) Nucleus : It contains chromosomal material which is the carrier of genetic information.

(iii) Middle piece : It contains mitochondria in spiral form that provides energy for the movement of the sperm hence also called "power house of the sperm".

26. (a) The reasons for causing infertility in couples other than physical and congenital are drugs and diseases (immunological or psychological factors could also result in infertility).

Sometimes alcohol addiction among males causes defective spermatogenesis and leads to infertility.

(b) IVF (*in vitro* fertilisation) is an assisted reproductive technology in which fusion of ovum and sperm is done outside the body of female (in almost similar conditions as that in the body) to form zygote which is allowed to divide to form embryo. This embryo is then implanted in uterus of female where it develops into a fetus which in turn develops into a child. This technique has helped many childless couples to have children.

(c) The differences between GIFT and ZIFT are :

	GIFT	ZIFT
(i)	Fertilisation occurs *in vivo*, *i.e.*, in fallopian tube.	Fertilisation occurs *in vitro*, *i.e.*, outside the body of female.
(ii)	Both eggs and sperms are introduced in the fallopian tube.	Zygote upto 8 blastomeres is introduced in the fallopian tube.

27. (a) A mass of finger like projections of wall at the micropylar tip called filiform apparatus is found in synergids of mature embryo sac of an angiosperm. It helps in guiding the pollen tubes towards the synergids.

(b) The anther with malfunctioning tapetum cannot provide complete nutrition to the developing microspores or male gametophytes. So, it fails to produce viable male gametophytes.

28. (a) Hormone 'X' is luteinising hormone (LH) and 'Y' is follicle stimulating hormone (FSH).

(b) **(i)** Follicular phase (proliferative phase)
  (ii) Ovulatory phase (release of ovum)
  (iii) Luteal phase (secretory phase)

(c) **(i)** Follicular phase-FSH is secreted by the anterior pituitary, that stimulates the ovarian follicle to secrete estrogen, which stimulates the proliferation of the endometrium of the uterine wall.

(ii) Ovulatory phase - Both LH and FSH attain a peak level in the middle of cycle (about 14th day). Rapid secretion of LH leading to its maximum level during the mid-cycle is called LH surge. It induces rupture of Graafian follicle and thereby the release of ovum (ovulation).

Due to these events, this phase is termed as ovulatory phase of menstrual cycle.

(iii) Luteal phase - The remaining cells of ovarian follicles are stimulated by the LH to develop corpus luteum. The corpus luteum secretes large amount of progesterone, which is essential for the maintenance of endometrium. This is known as luteal phase.

29. (a) 'X' is the natural method of contraception which do not involve medication or devices to prevent pregnancy.

(b) Natural methods (X) avoid meeting of sperm and ova and thus prevent fertilisation.

(c) The various examples of natural method are periodic abstinence or rhythm method, coitus interruptus or withdrawal method and lactational amenorrhea method.

OR

(d) No medicines or devices are used in natural methods, so side effects are almost nil. Chances of failure of natural methods are quiet high.

30. (a) In the given figure, A is zona pellucida. It induces changes in the membrane that block the entry of additional sperms.

(b) B here is perivitelline space between the zona pellucida and oocyte membrane. Now, after the ovum has been fertilised by a sperm, then in order to prevent polyspermy the cortical granules are released by the ovum in the perivitelline space. This prevents attachment of sperm to zona pellucida, preventing polyspermy.

(c) C are the cells of corona radiata.

OR

(d) As the sperm reaches zona pellucida, it will induces the completion of the meiotic division of the secondary oocyte. The second meiotic division results in the formation of a second polar body and a haploid ovum.

31. (a) (i) Infertility can happen due to following reasons :

- Infertility in males can be due to low sperm count, blockage of vasa deferentia and vasa efferentia affecting sperm transport, hormonal deficiency, impotency (inability to erect and penetrate penis into vagina of female) and presence of anti-sperm antibodies in semen.
- Infertility in females can be due to ovulation disorders, abnormality in uterus, blockage or damage to fallopian tubes, chronic endometritis, fibroid in uterus, etc.

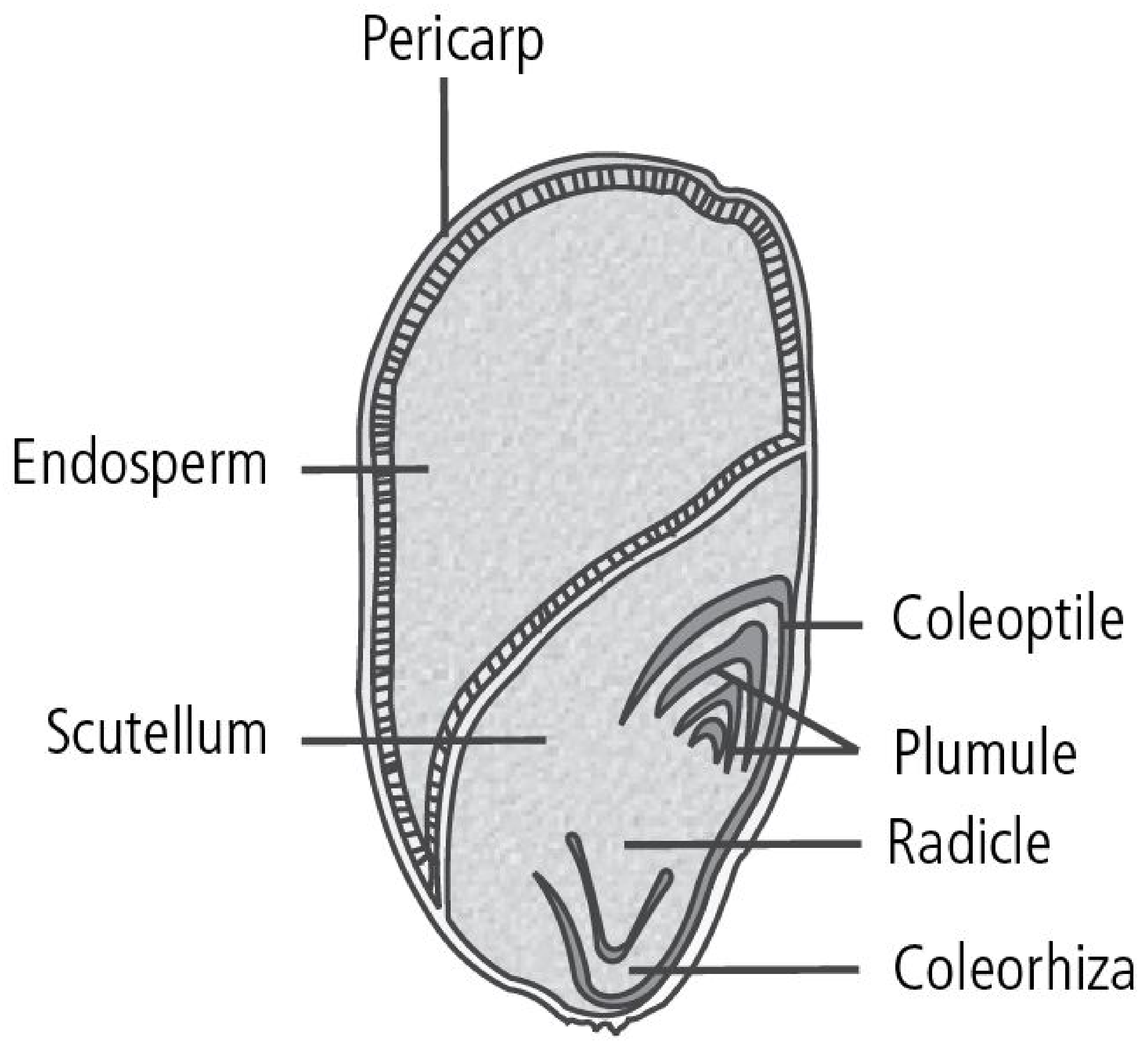
(ii) If the problem is with a male partner then artificial insemination technique can be adopted. In this technique, the sperms collected either from the husband or a healthy donor are artificially introduced either into the vagina or into the uterus (IUI-Intra-Uterine Insemination) of the female.

OR

(b) (i) In the given case, both the partners are producing normal gametes but female is unable to conceive. This means that there is some problem with fallopian tube or uterus or hormonal levels of the female. Thus, the method that we suggest to the couple is of surrogacy. In this method the ova from the wife and sperms from the husband are induced to form zygote in the laboratory. The zygote is then allowed to divide to form embryo. A developing embryo is then implanted in the uterus of another female (surrogate mother). The surrogate mother then gives birth to the child.

(ii) Copper containing intrauterine devices (CuT, Cu7, etc) are considered an effective contraceptives for human females as the Cu ions released by them suppress sperm motility and fertilising capacity of the sperms. Hence, they act as effective birth control method.

32. (a) (i) Longitudinal section of an albuminous seed of maize is as follows :



(ii) Importance of seeds to flowering plants are:

- Dependable method : Unlike bryophytes and pteridophytes, pollination and fertilisation of seed

TRIO

The same THREE LETTERS will complete these four words.

Can you find the three-letter sequence?

G U A – – – I N E

– – – T O C

D I A – – – I S

G Y M – – – P E R M S

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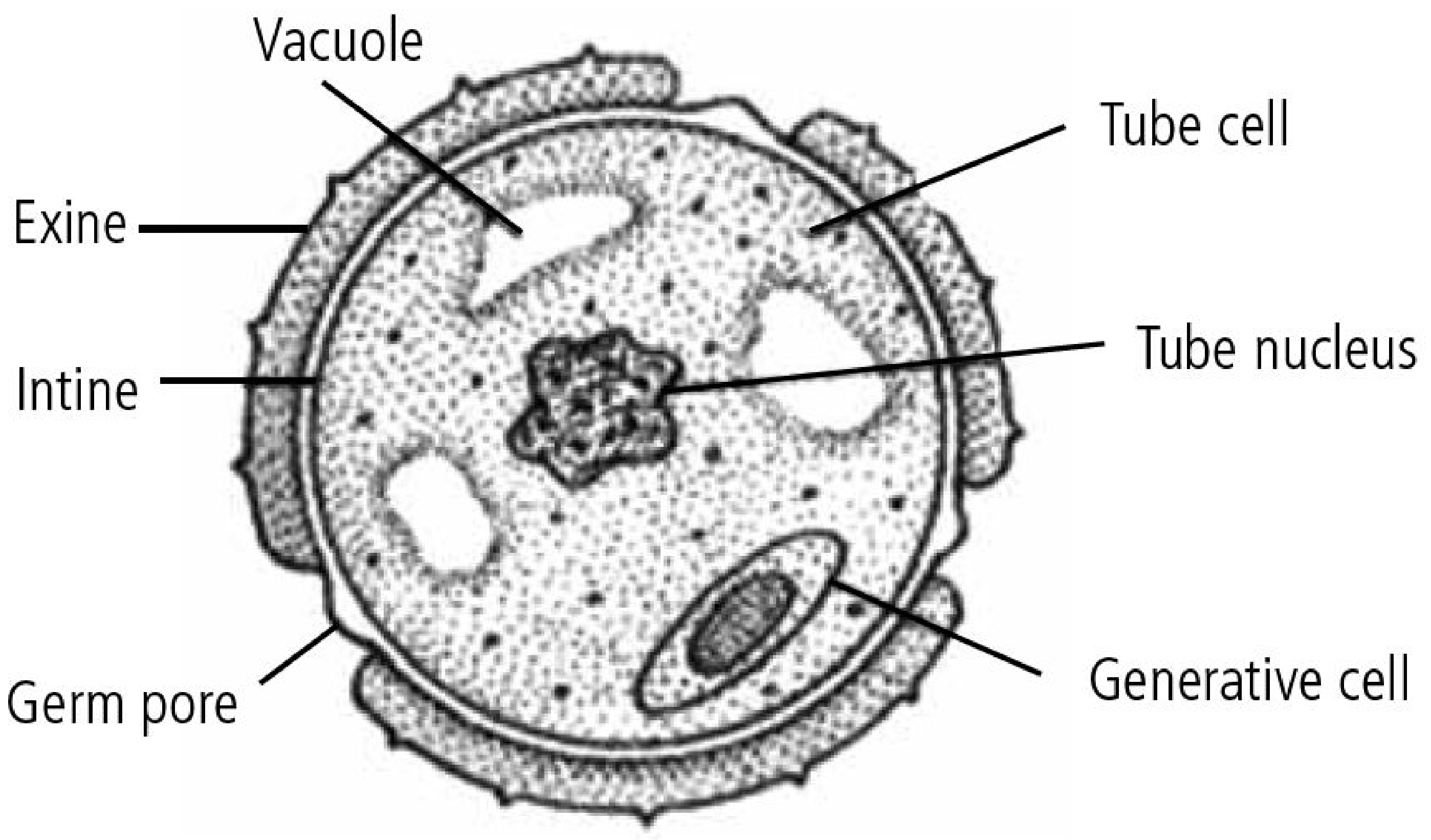
Winners' names will be published in next issue.

plants are free from requirement of water. Seed formation is, therefore. more dependable.

- Perennation : Seed is dry (water content 10-15%) with dormant embryo and thick protective seed coat. It is most suitable for perennation through unfavourable periods.
- Dispersal : Seeds have adaptive strategies to get dispersed to new habitats and colonise the same.
- Reserve Food : Seeds have reserve food for nourshing the young seedling still they become nutritionally independent.
- Variations : As seeds are formed through sexual reproduction they carry a number of variations. Variations are essential for adaptability to diverse environmental conditions.
- Storage : Seeds can be stored for later use. This is helpful for supply of food throughout the year and to overcome drought and famine conditions.
- Agriculture : Seed is the basis of agriculture. Agriculture originated when humans learnt to eat, store and sow seeds. Agriculture proved to the turning point for evolution of human civilisation, industrialisation, science and technology.

OR

(b) (i) The labelled diagram of a mature microspore of an angiosperm with its cellular components is as follows :


Vacuole
Exine
Intine
Germ pore
Tube cell
Tube nucleus
Generative cell

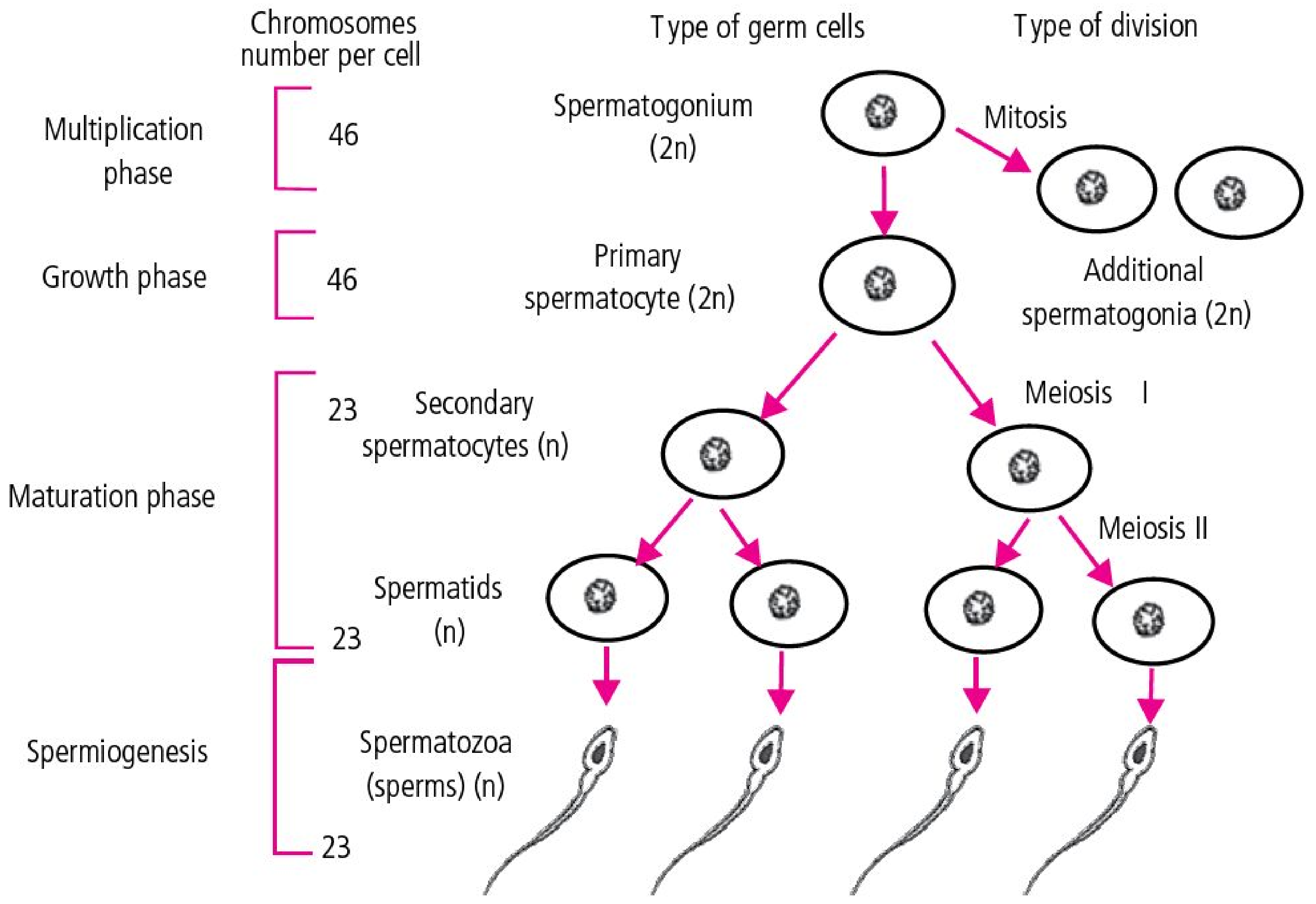
Functions of labelled parts are as follows:

(ii)
- Exine provides protection.
- Intine grows out as pollen tube through one of the germ pores on the exine.
- Vegetative cell contain food reserves, *i.e.*, starch, protein, fat.
- Generative cell divides mitotically to produce two male gametes.

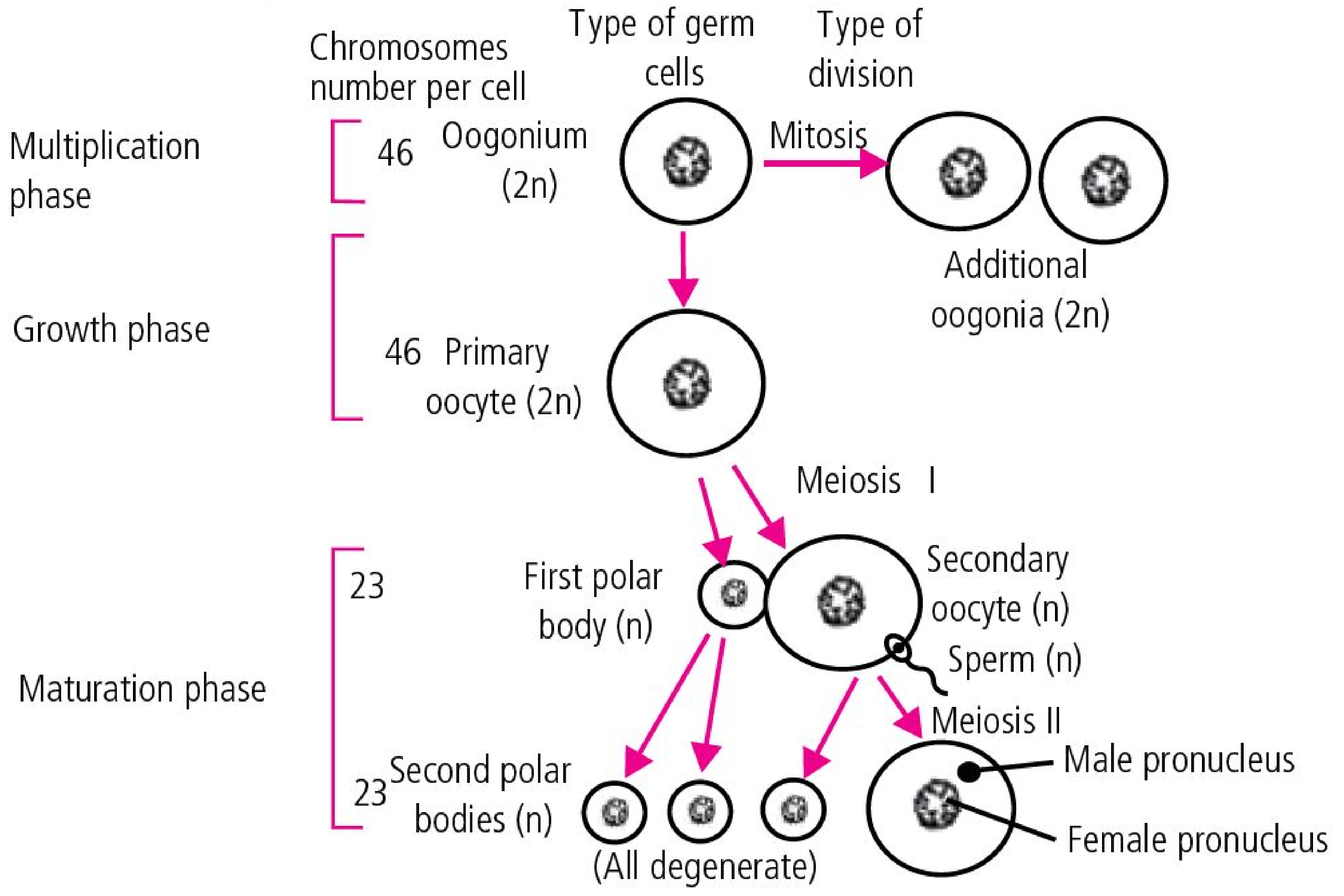
33. (a) (i) Primary spermatocyte divides by meiosis I to form two secondary spermatocytes. Primary oocyte undergoes meiosis I to form one secondary oocyte and one polar body. Secondary spermatocyte divides by meiosis II to produce two spermatids. Secondary oocyte divides by meiosis II to form one ovum and one polar body.

A spermatocyte forms four spermatozoa. An oocyte forms only one egg or ovum.

Different stages in spermatogenesis are shown below:


Chromosomes number per cell
Type of germ cells
Type of division
Multiplication phase
46
Spermatogonium (2n)
Mitosis
Additional spermatogonia (2n)
Growth phase
46
Primary spermatocyte (2n)
Maturation phase
23
Secondary spermatocytes (n)
Meiosis I
Meiosis II
Spermatids (n)
23
Spermiogenesis
Spermatozoa (sperms) (n)
23

Different stages in oogenesis are shown below :


Chromosomes number per cell
Type of germ cells
Type of division
Multiplication phase
46
Oogonium (2n)
Mitosis
Additional oogonia (2n)
Growth phase
46
Primary oocyte (2n)
Meiosis I
Maturation phase
23
First polar body (n)
Secondary oocyte (n)
Sperm (n)
Meiosis II
23
Second polar bodies (n)
(All degenerate)
Male pronucleus
Female pronucleus

(ii) Unequal cell divisions during oogenesis, makes the ovum much larger than the other three polar bodies. Ovum has more cytoplasm and more organelles, it has a better chances of surviving. The male makes million of tiny sperms while, the female makes one egg per month because the sperms have to search for the eggs and only a few succeed in this task.

OR

(b) (i) During ovulatory phase, in the middle of the menstrual cycle (about 14th day), both luteinising hormone (LH) and follicle stimulating hormone (FSH) attain a peak level. Rapid secretion of LH induces rupturing of Graafian follicle and thereby the release of ovum. This is called ovulation caused by LH.

(ii) In secretory phase, the cells of ovarian follicles are stimulated by LH to develop corpus luteum. The corpus luteum secretes large amount of progesterone which is essential for maintenance of pregnancy. Progesterone also stimulates the uterine glands to produce increased amount of watery mucus. ☺☺

Class XII

Monthly test drive

This specially designed column enables students to self analyse their extent of understanding of specific chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 160 **Time :** 40 Min.

Series IV Principles of Inheritance and Variation

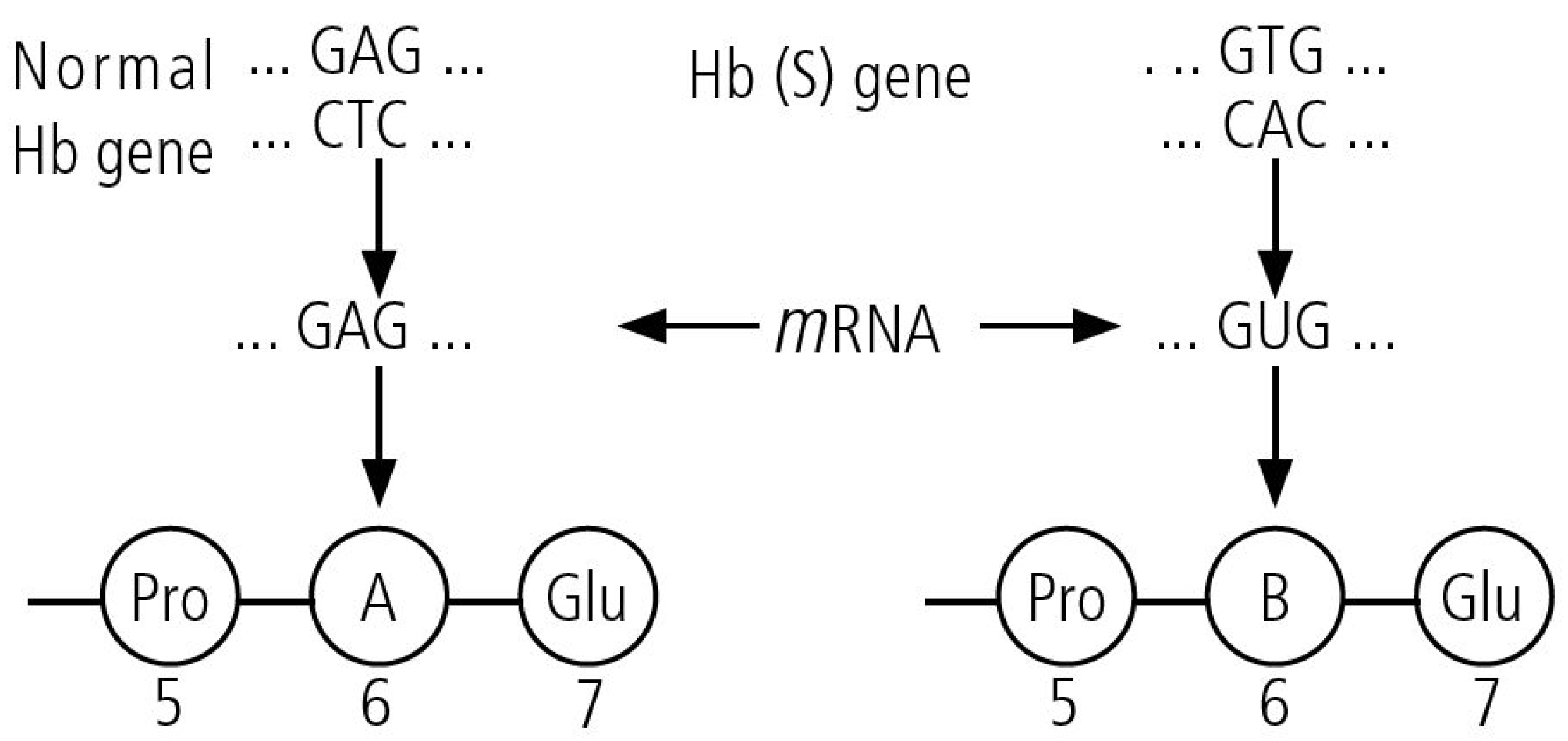
1. The colour based contrasting traits out of seven contrasting pairs, studied by Mendel in pea plant were
   (a) 1 (b) 2
   (c) 3 (d) 4.

2. Match the items given under column I with those under column II and select the correct option.

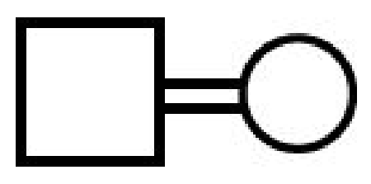
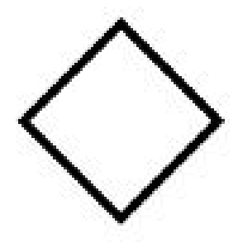
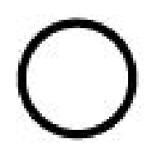
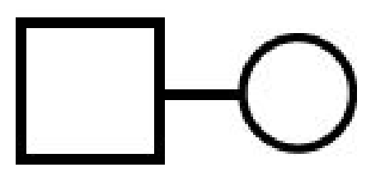
Column I (Terms)	Column II (Meaning)
(1) Genotype	(p) An organism produced by a cross between two individuals differing in certain characters
(2) Recessive	(q) Observable characteristics of an organism
(3) Hybrid	(r) The trait that remains hidden in a heterozygote
(4) Phenotype	(s) An organism with contrasting alleles of a character
	(t) Genetic constitution of an organism

   (a) (1) – (t), (2) – (r), (3) – (p), (4) – (q)
   (b) (1) – (t), (2) – (r), (3) – (q), (4) – (p)
   (c) (1) – (t), (2) – (r), (3) – (s), (4) – (q)
   (d) (1) – (q), (2) – (t), (3) – (s), (4) – (p)

3.



In the given amino acid composition of a portion of β-chain of haemoglobin, A and B are respectively
   (a) Val and His (b) Glu and Val
   (c) Leu and Thr (d) Pro and Glu.

4. Which one is the incorrect match?
   (a)  – Consanguineous mating
   (b)  – Sex unspecified
   (c)  – Male
   (d)  – Mating

5. Select the correct statement.
   (a) Tightly linked genes on the same chromosome show very few recombinations.
   (b) Tightly linked genes on the same chromosome show more recombinations.
   (c) Genes apart on the same chromosome show very few recombinations.
   (d) Genes loosely linked on the same chromosome show similar recombinations as the tightly linked ones.

6. Sex of a human child is determined by
   (a) size of the egg at the time of fertilisation
   (b) size of the sperm at the time of fertilisation
   (c) sex chromosome of father
   (d) sex chromosome of mother.

7. If in a dihybrid cross Mendel had used two such characters which have linked, he would have faced difficulty in explaining the results on the basis of his
   (a) Law of segregation
   (b) Law of multiple factor hypothesis
   (c) Law of independent assortment
   (d) Law of dominance.

8. Match the columns and find out the correct combination.

	Column I		Column II
A.	G.J. Mendel	1.	Chromosomal theory of inheritance
B.	T.H. Morgan	2.	Discovered linkage in *Drosophila*
C.	Sutton and Boveri	3.	Proposed laws of heredity

(a) A-3, B-2, C-1 (b) A-1, B-2, C-3
(c) A-2, B-3, C-1 (d) A-3, B-1, C-2

9. **Assertion (A) :** Phenylketonuria is a recessive hereditary disease caused by body's failure to oxidise an amino acid phenylalanine to tyrosine, because of a defective enzyme.
Reason (R) : It results in the presence of phenylpyruvic acid in urine.

(a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is not correct.
(d) (A) is not correct but (R) is correct.

10. The genotypes of a husband and wife are I^AI^B and I^Ai. Among the blood types of their children, how many different genotypes and phenotypes are possible?

(a) 3 genotypes, 4 phenotypes
(b) 4 genotypes, 3 phenotypes
(c) 4 genotypes, 4 phenotypes
(d) 3 genotypes, 3 phenotypes

11. Which of the following is a correct match?

(a) Down's syndrome – 21st chromosome
(b) Sickle cell anaemia – X-chromosome
(c) Haemophilia – Y-chromosome
(d) Klinefelter's syndrome – XO females

12. In which of the following syndrome gynaecomastia is expressed?

(a) Klinefelter's syndrome
(b) Turner's syndrome
(c) Down's syndrome
(d) Both (b) and (c)

13. Multiple alleles control inheritance of

(a) blood group (b) colourblindness
(c) sickle cell anaemia (d) phenylketonuria.

14. A trait / genetic disorder in human which is a case of pleiotropy is ________ .

(a) haemophilia (b) phenylketonuria
(c) colour blindness (d) Huntington's chorea

15. Test cross involves

(a) crossing between two genotypes with dominant trait
(b) crossing between two genotypes with recessive trait
(c) crossing between two F_1 hybrids
(d) crossing the F_1 hybrid with a double recessive genotype.

16. Observe the sex determination in the following columns and select the correct option.

	Column-I		Column- II
(A)	Male heterogamety	(1)	Human XY
(B)	Female heterogamety	(2)	Hen ZW
(C)	Male homogamety	(3)	*Drosophila* XY
		(4)	Grasshopper XO
		(5)	Birds ZZ

	A	B	C
(a)	3, 4	1	2
(b)	3, 4	2	1
(c)	2, 4	1	3
(d)	1, 3, 4	2	5

17. Pure homozygous offsprings in a dihybrid cross in the F_2 generation will be

(a) 1/2 (b) 1/4
(c) 1/8 (d) 1/16

18. Read the given statements and select the correct option.
Statement I : Mendel's experiment had large sampling size.
Statement II : He did not applied statistical analysis to his experiments.

(a) Both statements I and II are correct.
(b) Statement I is correct but statement II is incorrect.
(c) Statement I is incorrect but statement II is correct.
(d) Both statements I and II are incorrect.

19. Sickle-cell anaemia is

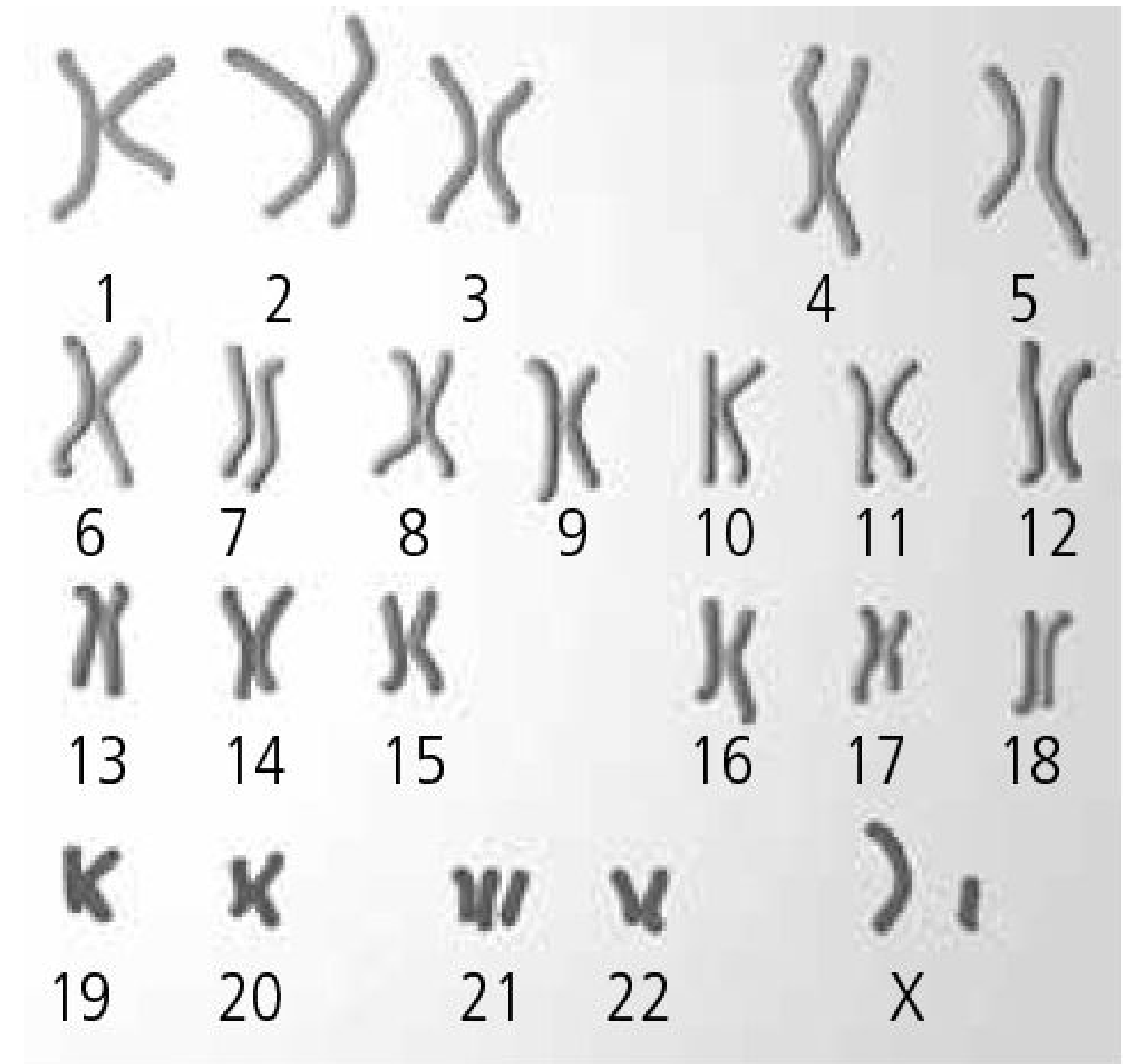
(a) caused by substitution of valine by glutamic acid in the beta globin chain of haemoglobin
(b) caused by a change in a single base pair of DNA
(c) single base substitution at the fifth codon of alpha globin gene
(d) an autosomal linked dominant trait.

20. Pick out the correct statements.

A. Haemophilia is a sex-linked recessive disease.
B. Down's syndrome is characterised by palm crease.
C. Phenylketonuria is an autosomal recessive trait.
D. Sickle cell anaemia is an X-linked recessive trait.

(a) (A) and (D) are correct.
(b) (B) and (D) are correct.
(c) (A), (C) and (D) are correct.
(d) (A), (B) and (C) are correct.

21. The given karyotype depict



(a) Turner's syndrome (b) Klinefelter's syndrome
(c) Down's syndrome (d) Sickle cell anaemia.

22. In the XX-XO type of sex determination
(a) females produce only one type of eggs
(b) females have only one X-chromosome
(c) males have two X-chromosomes
(d) males are homogametic.

23. A man of A-blood group marries a woman of AB blood group. Which type of progeny would indicate that man is heterozygous A?
(a) AB (b) A
(c) O (d) B

24. Match the items given in column I with those listed in column II. Choose the answer with correct combination of alphabets of the two columns.

	Column I		Column II
(A)	Monohydrid cross	(1)	T and t
(B)	Test cross	(2)	TT
(C)	Alleles	(3)	Tt × Tt
(D)	Homozygous tall	(4)	tt
		(5)	Tt × tt

	A	B	C	D
(a)	3	5	4	2
(b)	5	3	2	4
(c)	3	5	1	2
(d)	3	1	5	2

25. **Assertion (A) :** In a monohybrid cross, F_1 generations indicate dominant characters.
Reason (R) : Dominance occurs only in heterozygous state.
(a) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(b) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(c) (A) is correct but (R) is not correct.
(d) (A) is not correct but (R) is correct.

26. Select the incorrect statement.
(a) Chromosomes as well as genes occur in pairs.
(b) Mendel could not provide any physical proof for the existence of factors.
(c) In the Mendelian dihybrid cross, segregation of one pair of characters are independent from the segregation of the other pair of characters.
(d) Distantly located genes assort together.

27. The frequency of recombinant gametes in a dihybrid plant is
(a) 25% (b) 75%
(c) 50% (d) 100%.

28. When a homozygous red flower of snapdragon plant is crossed with a white flowered plant, what colour is produced in F_1?
(a) Red (b) White
(c) Pink (d) Patches of Red and white

29. Match the terms in column I with their description in column II and choose the correct option.

	Column I		Column II
A.	Dominance	(i)	Many genes govern a single character
B.	Co-dominance	(ii)	In a heterozygous organism only one allele expresses itself
C.	Pleiotropy	(iii)	In a heterozygous organism both alleles express themselves fully
D.	Polygenic inheritance	(iv)	A single gene influences many characters

	A	B	C	D
(a)	(iv)	(i)	(ii)	(iii)
(b)	(iv)	(iii)	(i)	(ii)
(c)	(ii)	(i)	(iv)	(iii)
(d)	(ii)	(iii)	(iv)	(i)

30. Which following pair of diseases is caused by the genes located on human X-Chromosome ?
(a) Colour blindness and phenylketonuria
(b) Colour blindness and haemophilia
(c) Colour blindness and albinism
(d) Colour blindness and hypertrichosis

31. Identify the wrong statement.
(a) Alleles I^B and I^C also produce sugar polymers on surface of RBC.
(b) Alleles I^A and I^B produce sugar polymers on surface of RBC.
(c) When I^B and I^B or i are present then only I^B is expressed.
(d) When I^A and I^B are present together then both of them express because of co-dominance.

32. Polyploidy is
(a) increase in whole set of chromosomes
(b) gain of one chromosome
(c) loss of one chromosome
(d) base pair substitution.

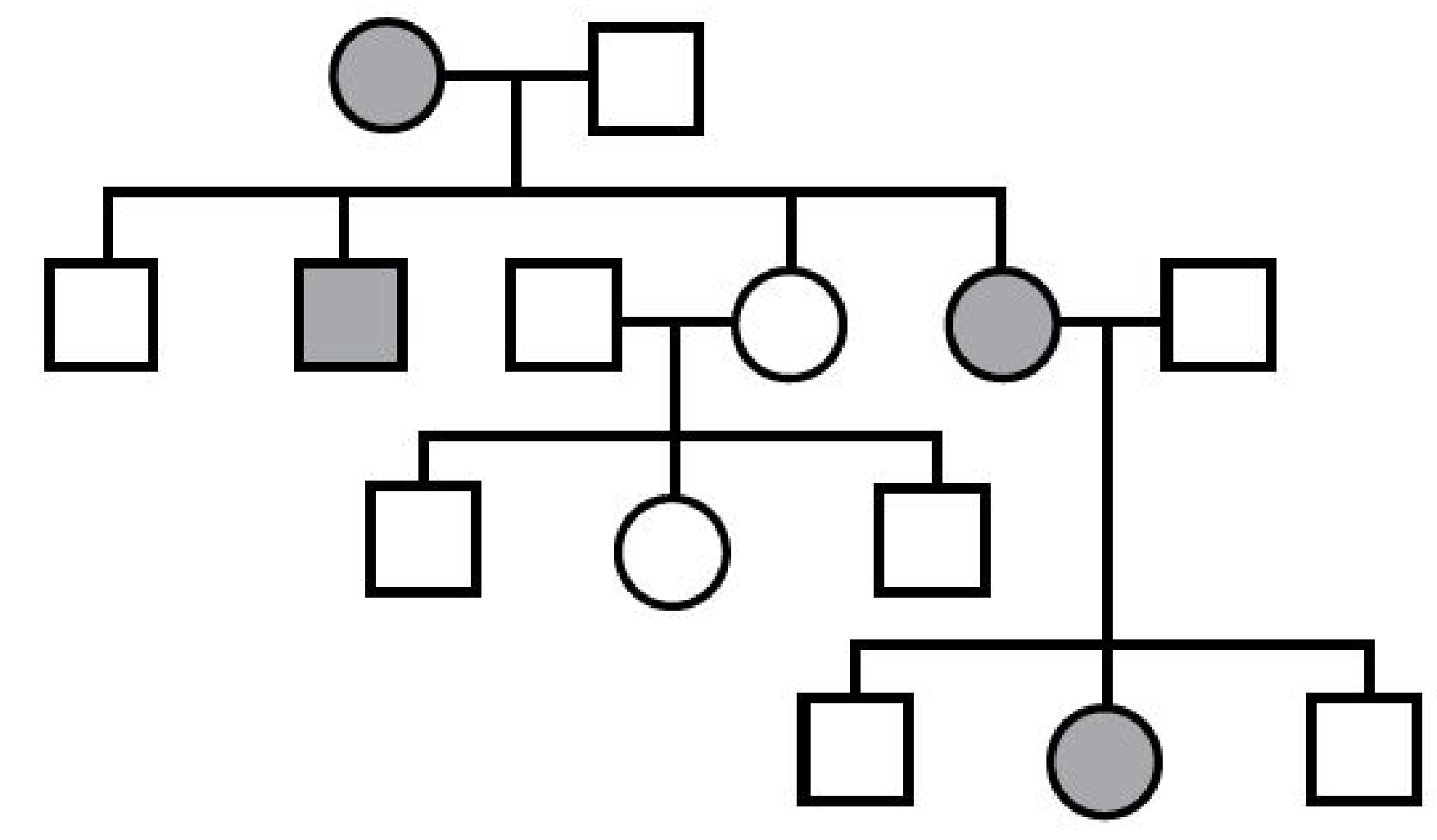
BIO BUZZ **ANSWERS June 2025**

1. Diptera
2. Neurons
3. Alleles
4. Enzymes
5. Asexual
6. Histone
7. Cocaine

33. Some of the dominant traits studied by Mendel were
(a) round seed shape, constricted pod shape and axial flower position
(b) green pod colour, inflated pod shape and axial flower position
(c) yellow seed colour, violet flower colour and yellow pod colour
(d) axial flower position, green pod colour and green seed colour.

34. Frameshift mutation or base pair substitution changes the
(a) sugar phosphate sequence
(b) base pair sequence
(c) nucleoside sequence
(d) none of these.

35. Find out the correct pattern of inheritance in the pedigree chart given below.



(a) X-linked dominant trait
(b) X-linked recessive trait
(c) Autosomal dominant trait
(d) Autosomal recessive trait

36. With respect to Down's syndrome, identify the incorrect statement.
(a) It is due to trisomy of chromosome11.
(b) Affected individual has furrowed tongue and partially opened mouth.
(c) Palm is broad with characteristic palm crease.
(d) Mental development is retarded.

37. Match column I with column II and select the correct option.

	Column I		**Column II**
P.	Pleiotropy	(i)	Flower colour in *Antirrhinum majus*
Q.	Polygenic inheritance	(ii)	Sickle cell anaemia
R.	Co-dominance	(iii)	Coat colour in cattle
S.	Incomplete dominance	(iv)	Human skin colour

(a) P-(iv), Q-(ii), R-(iii), S-(i)
(b) P-(ii), Q-(iv), R-(iii), S-(i)
(c) P-(ii), Q-(iv), R-(i), S-(iii)
(d) P-(iii), Q-(i), R-(iv), S-(ii)

38. According to Mendelism which one of the given character is showing dominance?
(a) Terminal position of flower
(b) Green seed
(c) Wrinkled seeds
(d) Green pod colour

39. To determine whether F_1 hybrid is homozygous or heterozygous for a particular trait ________ cross is performed.
(a) monohybrid (b) test
(c) back (d) reciprocal

40. In case of incomplete linkage, the parental combinations obtained in F_1 generation are
(a) 100% (b) more than 50%
(c) 25% (d) less than 50%. ☺☺

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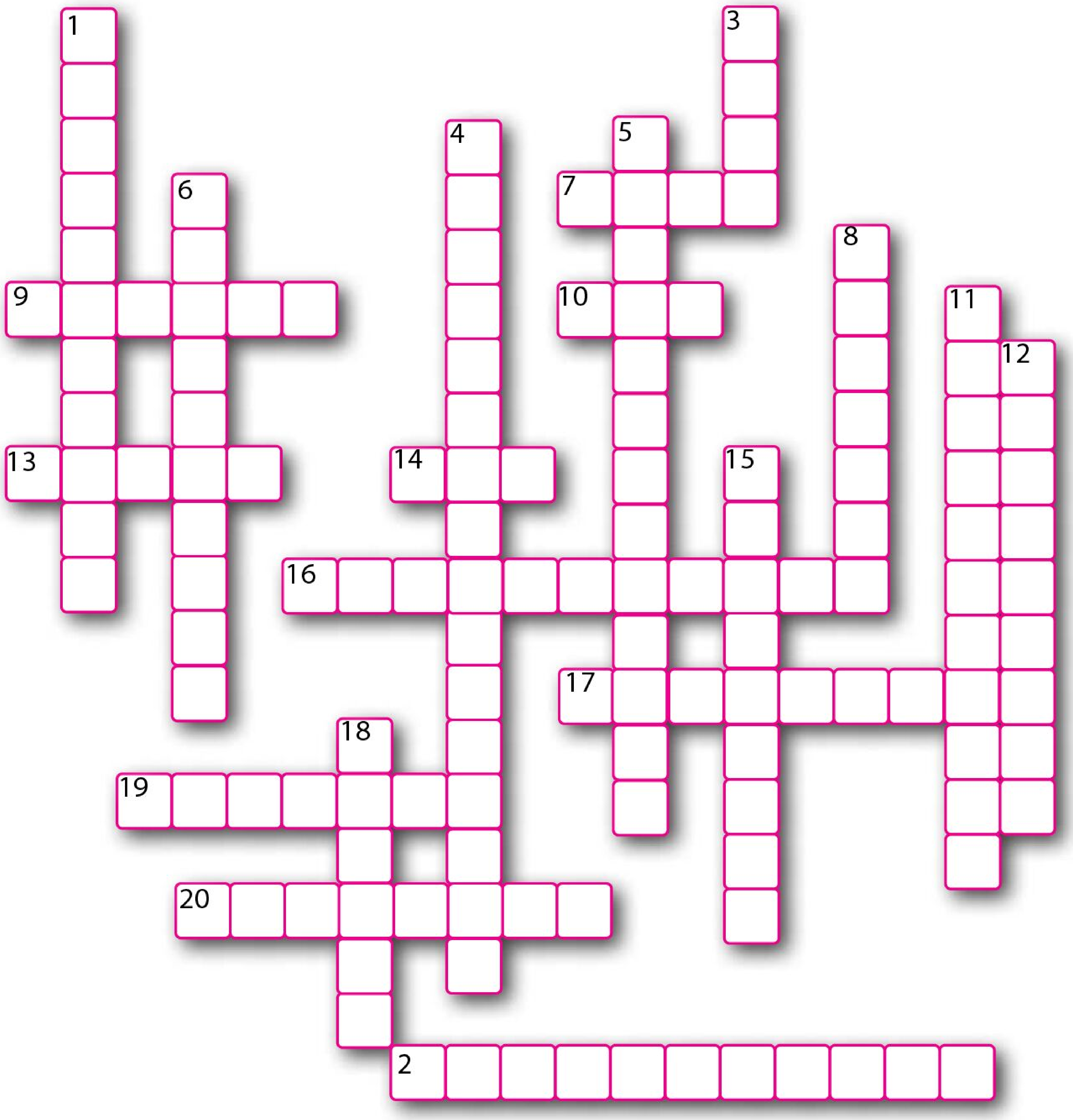
Read the given clues and solve the crossword with correct words.



ACROSS

2. The process of conversion of RNA into proteins.

7. Brings amino acids from cytoplasm to a ribosome.

9. In DNA its place is taken by thymine.

10. Contains uracil and is single-stranded.

13. Set of three bases.

14. Genetic material of most of the organisms.

16. Built from a large number of amino acids.

17. A sphere-shaped structure within the cytoplasm of the cell that is composed of RNA and protein and is the site of protein synthesis.

19. Paired with thymine in double-stranded DNA.

20. Paired with guanine in double-stranded DNA.

DOWN

1. The sugar found in DNA.

3. It is the end product of post transcriptional modification.

4. Process by which the genetic code puts together proteins in the cell.

5. The process of conversion of DNA into RNA.

6. A compound consisting of a nitrogenous base, sugar and a phosphate group.

8. This pairs with adenine in double-stranded DNA.

11. The shape of DNA.

12. The site of *t*RNA that reads codon.

15. The building blocks of all biological proteins.

18. Type of sugar found in RNA.

FIELD NOTE

Snow Leopard

Scientific Name : *Panthera uncia*
IUCN Red List Status : Vulnerable
Population Trend : Decreasing

Nest

Snow leopards are found in the high mountain regions of Central and Southern Asia, specifically in mountainous areas across 12 countries. These countries include Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan, and Uzbekistan.

Features

Snow leopards have spotted white-greyish fur that keeps them well insulated in cold weather – it can be 5 cm long on their back and sides and almost 12 cm long on their belly. A snow leopard's tail can reach up to 80-105 cm long, which is thought to help with balance, as well as wrap around its body for added warmth.

Diet

The snow leopard is a carnivore and actively hunts its prey. Its preferred wild prey species are Himalayan blue sheep, Himalayan tahr, argali, markhor and wild goat. It also preys on domestic livestocks. It prefers prey ranging in weight from 36 to 76 kg, but also hunts smaller mammals such as Himalayan marmot, pika and vole species.

Breeding

Snow leopard breeding typically occurs during the late winter months, from January to mid-March, with females giving birth in June or July after a gestation period of 90-100 days. A litter usually consists of two to three cubs, though in rare cases, there can be up to seven. Wild snow leopards pair up and travel together for a few days during the breeding season.

Threats

Poaching and Illegal Trade: Snow leopards are poached for their fur, bones, and other body parts, which are used in traditional Asian medicines. The illegal trade of these parts is a major driver of the decline in snow leopard populations.

Habitat Loss and Fragmentation: Human activities, such as settlement, agriculture, and infrastructure development, are shrinking and fragmenting snow leopard habitat. Roads and railroads can further isolate snow leopard populations and reduce their available hunting grounds.

Climate Change: Rising temperatures and altered precipitation patterns are impacting snow leopard habitats and the availability of prey. Climate change can also lead to habitat fragmentation and reduced access to resources.

INTERESTING FACTS

- Their fur provides excellent camouflage, blending with the rocky terrain and snow.
- A long, thick tail provides balance, helps them wrap around their bodies for warmth, and helps them navigate rocky terrain.
- Their small ears minimize heat loss.

Protection

In India, snow leopards are protected under the Wildlife (Protection) Act, 1972, and are listed in Schedule I, which grants them the highest level of protection. This means that hunting, killing, or trading snow leopards or their parts is illegal. Additionally, India has implemented Project Snow Leopard (PSL) and is part of the Global Snow Leopard and Ecosystem Protection (GSLEP) Program to conserve the species and its habitat.

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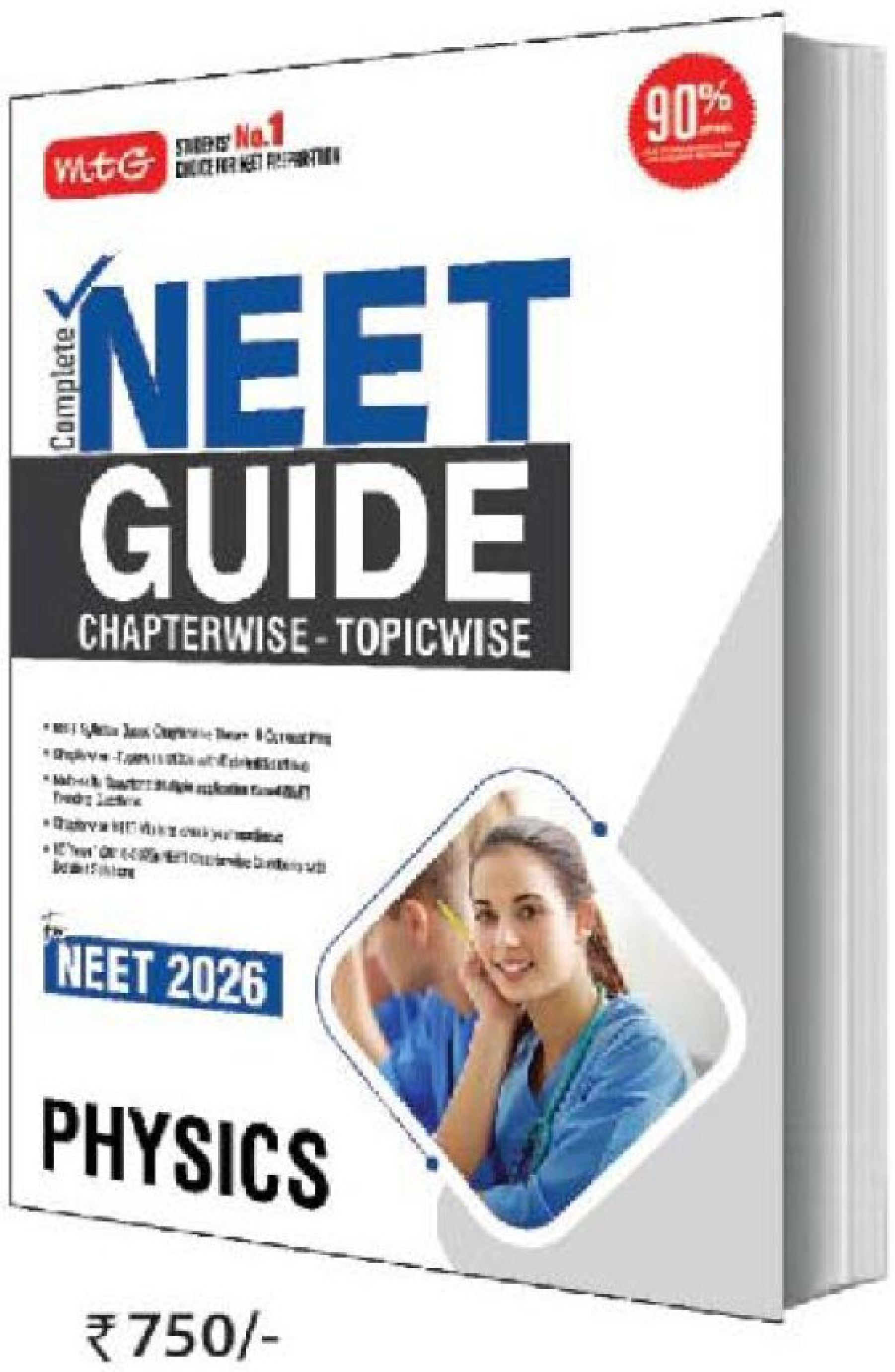
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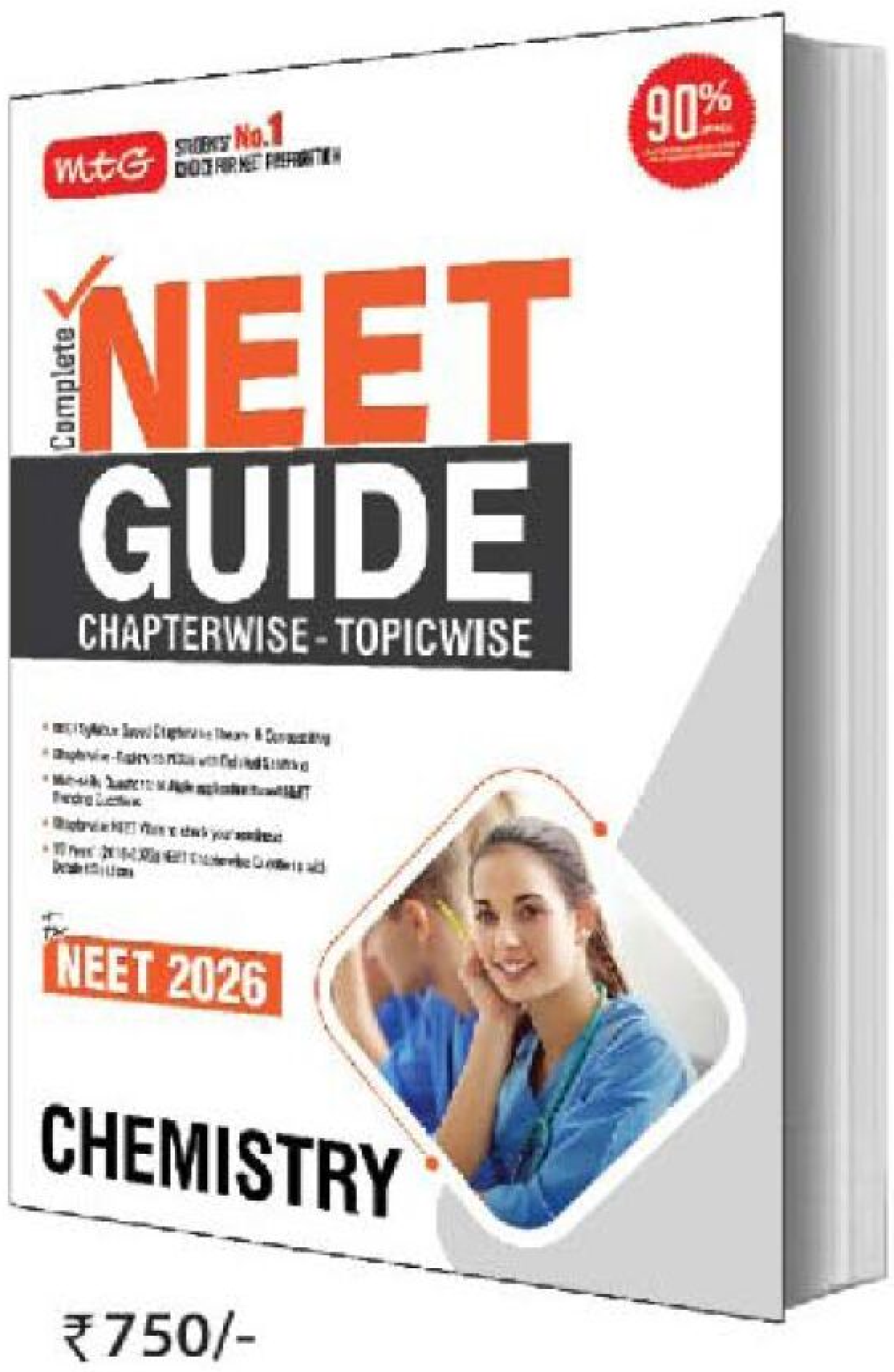
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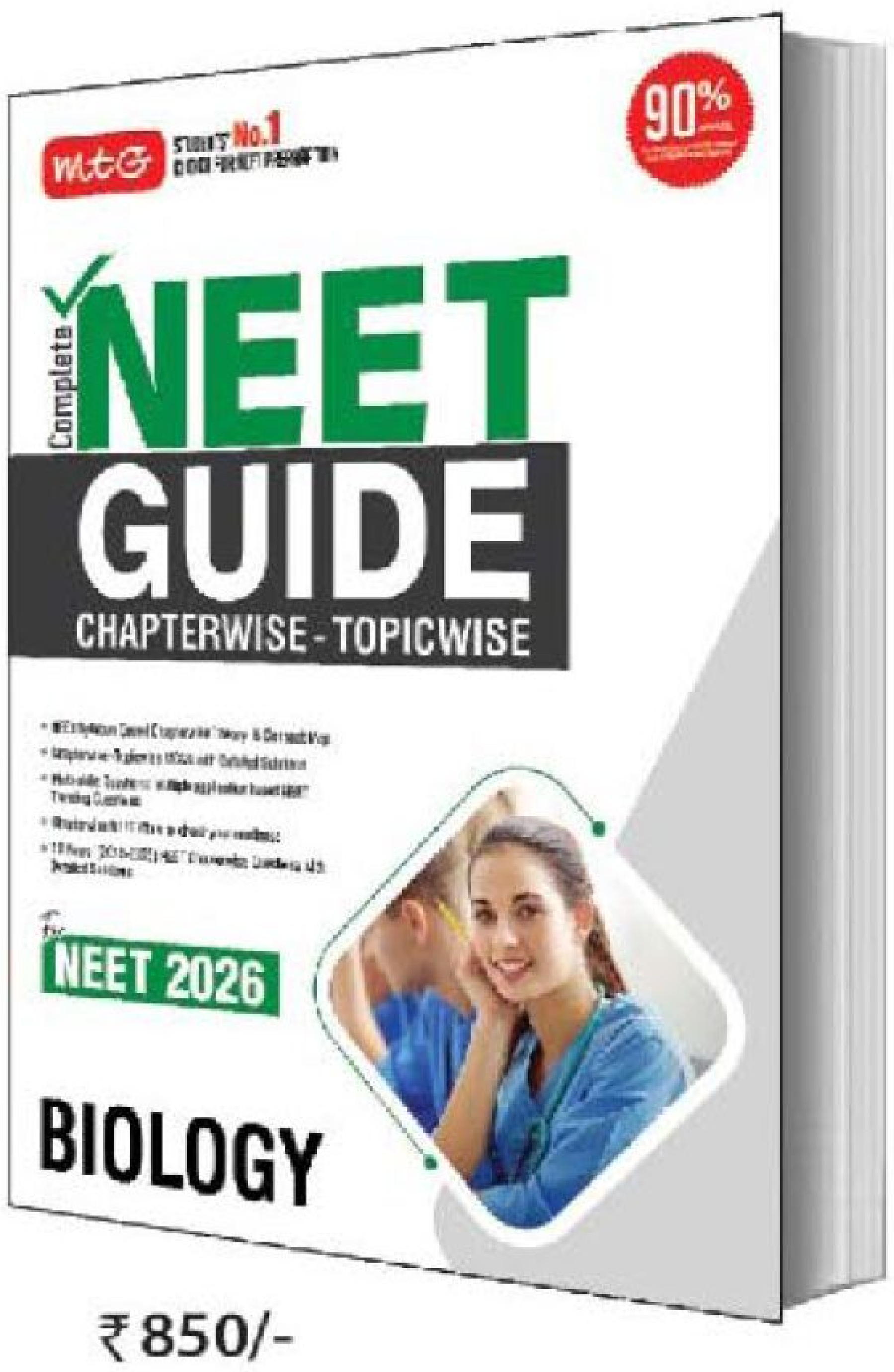
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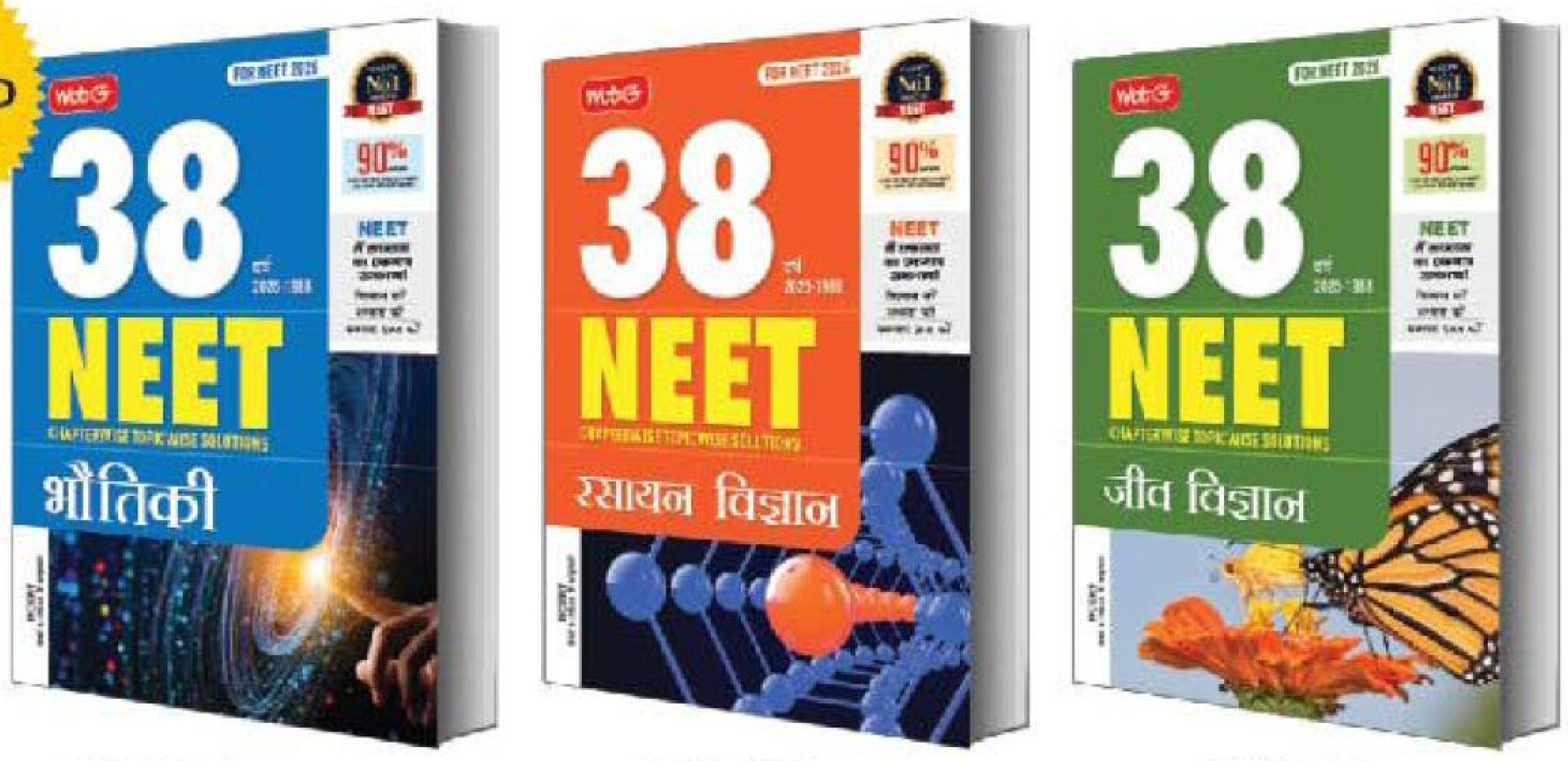

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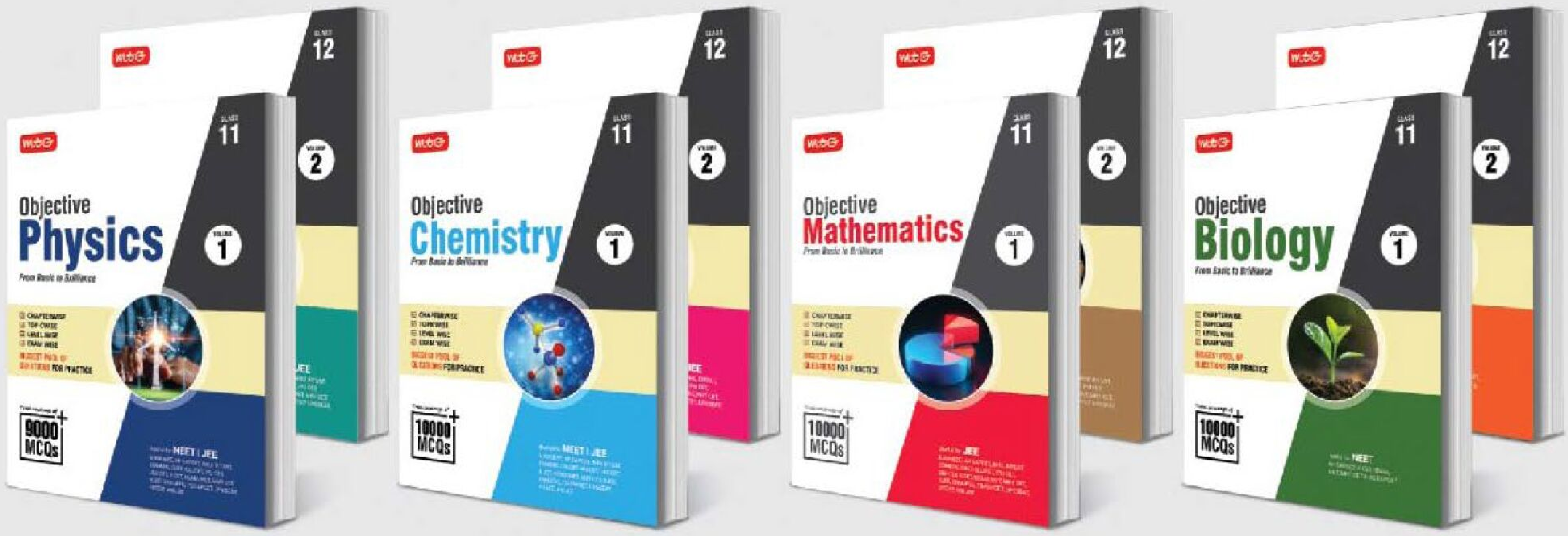
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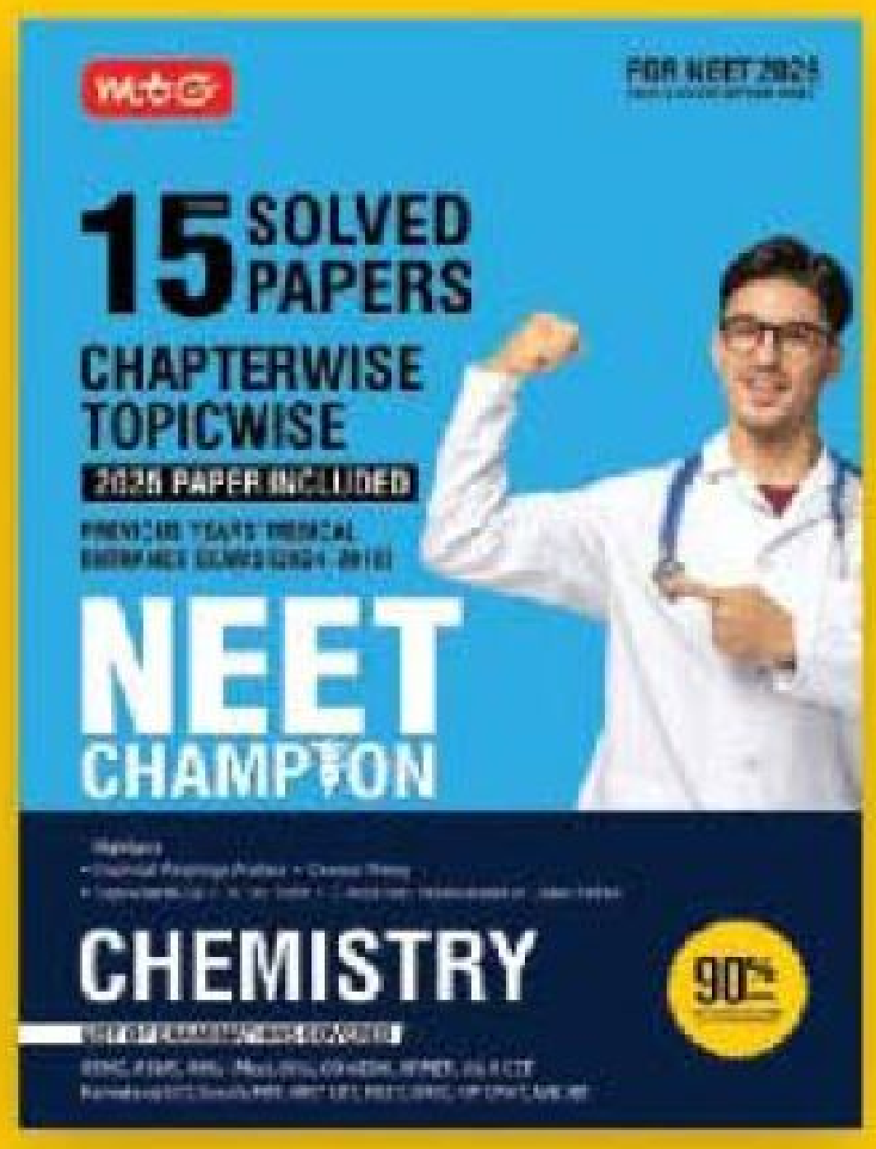
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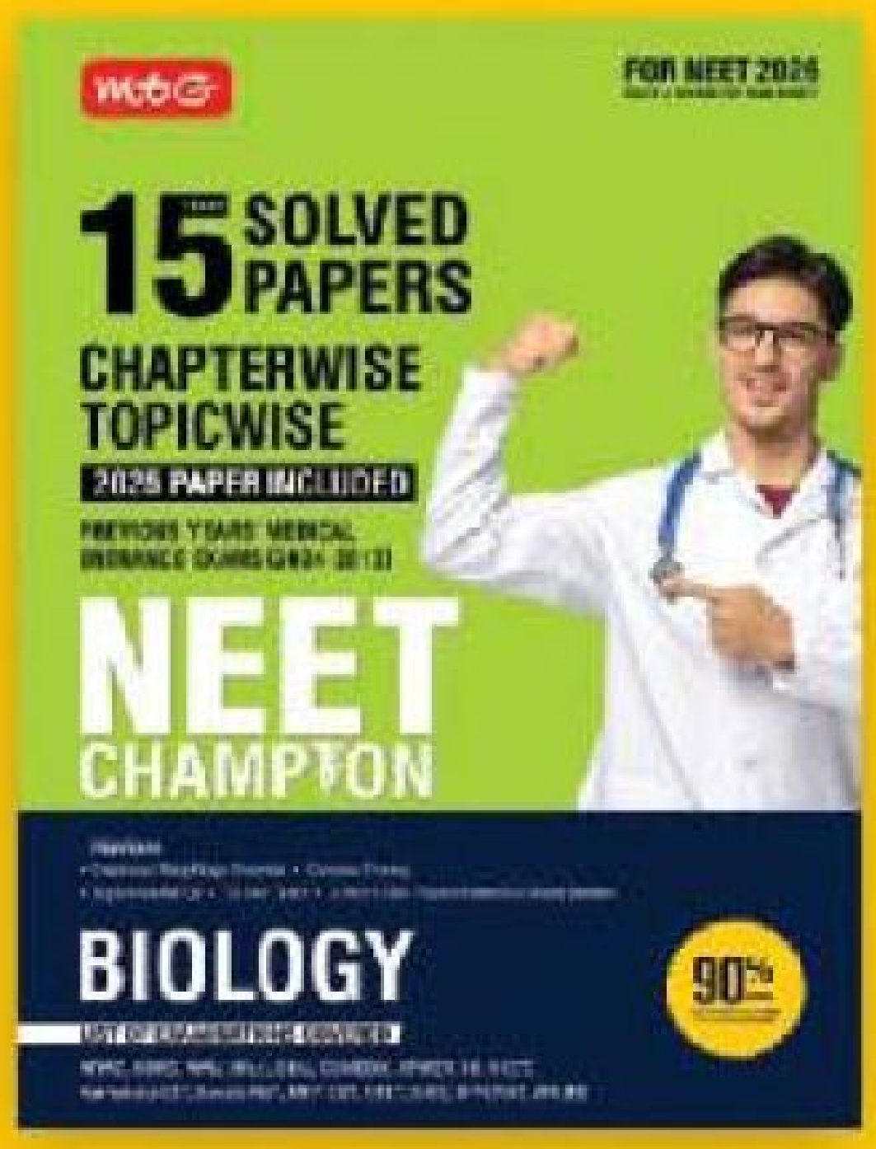
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